PROCEEDINGS OF

THE LINNEAN SOCIETY OF LONDON

Session 1950–51

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PROCEEDINGS OF THE GENERAL MEETING ON 12 October 1950

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the Anniversary Meeting held on Wednesday, 24 May 1950, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. G. O. Allen, Mr. W. C. Barton, Dr. H. A. Baylis, Dr. F. Børgesen, Dr. A. Tindell Hopwood, Mrs. L. V. McCleverty, Mr. O. B. Miller, Dr. H. F. Mooney, C.I.E., O.B.E., Mr. Richard Morse, Prof. J. Omer-Cooper, Mr. A. A. Pearson, Dr. R. E. Schultes, Dr. W. G. Templeman, Dr. A. H. Uggla, R.N.O., R.V.O., Prof. F. E. Weiss, F.R.S., Messrs. John Lane, Ltd., and the British Council.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Dr. Arthur James Cain, Miss Mary Rosalie Jane Edwards, Dr. Harold Gorvett, Mr. E. C. T. Holsinger, Mr. Frederick George Brook Jones, Mr. William Herbert Ebenezer Rivett and Mr. Bryan Sidney Young.

Certificates of recommendation for election to ordinary Associateship were read for the first time, in favour of Donald Eric Caulton, Miss Patricia Mann, B.Sc., Walter William Pollard, B.Sc., and Merfyn Richards, B.A.

The President reported the following deaths :—Mr. Frederick James Chittenden, Mr. Henry John Jeffery, Sir Murdoch McLeod, Bt., Mrs. Helen Holme Simmons (*née* Bancroft), Field-Marshal the Right Hon. Jan Christiaan Smuts, O.M., P.C., F.R.S., Mrs. Charles Urquhart Stuart, Mr. Harold Walkden and Mr. Ronald Winckworth, Fellows of the Society; and Prof. Merritt Lyndon Fernald, Foreign Member.

The following communications were read and discussed—

Prof. A. BOYDEN. The Rutgers University Serological Museum. (Discussed by Dr. W. C. Osman Hill and Dr. A. Tindell Hopwood; Prof. Boyden replied.)

Mr. E. A. C. L. E. SCHELPE. The Vegetation of Mount Kenya, illustrated by a coloured cine film. (Discussed by Dr. W. B. Turrill, Dr. Hugh Scott, F.R.S., and Dr. W. B. Gourlay.)

Abstract,—

An account of the vegetation of Mount Kenya (East Africa) was given and its climatic environment discussed. Although more than half of the species occurring in the alpine zone are endemic, more or less closely related species may be found on other tropical African mountains.

These endemic species may have arisen as a result of parallel evolution from a single widely spread forest architype isolated on each mountain or as a result of progressive isolation of populations on the highland masses and then on the peaks. Study of the distribution, habitats and degree of affinity of alpine species in some genera seems to indicate that a primary isolation on the present highlands and a secondary isolation on individual peaks has occurred. A consideration of the apparent limits of tolerance towards climatic conditions and competition of some alpine species (excluding those with efficient seed dispersal by wind) shows that these could have migrated from peak to peak on the same highland mass through a mosaic of moorland, Hagenia-Hypericum forest and bamboo. For such migration to have taken place between mountains on the same highland mass the climatic conditions on these highlands at 6000 ft. alt. in the late Pliocene would have had to be similar to those prevalent at 10,000 ft. alt. at the present time. This would require a postulate of a considerable rise in temperature since the Kamasian Pluvial (i.e. since 400,000 years ago).

The frequency of endemics on the ancient crystalline massifs, in contrast to the Tertiary volcanic peaks, was discussed.

PROCEEDINGS OF THE GENERAL MEETING ON 26 October 1950

Professor F. E. Fritsch, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 12 October 1950, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. Richard Morse, Mr. John Parkin, the Commonwealth Scientific and Industrial Research Organization, Melbourne, and the Editor of *Endeavour*.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Arthur John Ivens and Mr. Michael Haworth-Booth.

Candidates for ordinary Associateship were balloted for and elected :—Donald Eric Caulton, Miss Patricia Mann, B.Sc., Walter William Pollard, B.Sc., and Merfyn Richards, B.A.

The President reported the death of Sir Sidney Frederic Harmer, K.B.E., F.R.S., Fellow of the Society, and moved the following Resolution, which was passed in silence, all standing :—

> The Fellows of the Linnean Society of London, having heard with the deepest sorrow of the death of Sir Sidney Frederic Harmer, K.B.E., F.R.S., desire to place on record their high appreciation of the services he has rendered to the Society during the thirty-one years of his Fellowship. Elected in 1919, he served on the Council from 1921–24 and 1927–32. He was appointed Vice-President for 1931–32, and held the office of President from 1927–31. During his Fellowship of the Society he showed the greatest interest in its work and its Collections, both by frequent attendance at its meetings and by important communications on marine biology. Deploring the loss of so distinguished a Fellow, the Fellows desire to express to Lady Harmer and her family their deep sympathy with them in their bereavement.

The following communications were read and discussed :—

Mr. I. H. Burkill. Specimen of *Galinsoga*. [Exhibit.]

Mr. F. J. Manning. Recent and Fossil Honey Bees : Some Aspects of their Cytology, Phylogeny and Evolution. (Discussed by Mr. C. H. Hooper and Prof. F. E. Zeuner.)

RECENT AND FOSSIL HONEY BEES : SOME ASPECTS OF THEIR CYTOLOGY, PHYLOGENY AND EVOLUTION

By F. J. Manning.

(Plate 1 and a text-fig.)

During recent years much interest has centred on the honey bee, particularly following the work of von Frisch on the problem of intercommunication of these insects, and of Laidlaw, Mackensen and Roberts *et alii* in devising a more satisfactory technique of instrumental insemination. The cytological study, however, has long since waned following a period of great enthusiasm and promise at the beginning of the century. It seemed that Nachtsheim (particularly 1913) had progressed as far as possible with the older cytological techniques of sectioning and staining, and little more could be done until these had been replaced or greatly improved. That much useful work was accomplished at this time is nevertheless quite clear and the phenomenon of haploidy in the male with diploidy in the female was fairly firmly established. Yet to Nachtsheim it must have been most grievous to find that no sooner had one problem been resolved than others, seemingly insurmountable, immediately appeared. For instance, he appreciated, probably better than others, the haplo-diploid relationship of male and female, but because he also witnessed the half number of chromosomes in the primary oöcyte he had to propose his irksome hypothesis of 'Sammelchromosomen' in which single and double values were given to germ track chromosomes. Actually this half number is due to the fact that during nuclear division in the primary oöcyte there is a continued polarization of the chromosomes until diakinesis, thus separating them into two groups having the appearance of anaphase, but Nachtsheim was scarcely to know this in his earlier days. Great merit, in fact, must attach to his work for its meticulous care and accuracy, in spite of some erroneous conclusions.

It was not until 1948 that further specific work on the cytology of the honey bee was undertaken. Sanderson and Hall, of Dundee, using chiefly smears and having in mind Whiting's works on *Habrobracon* and the Hymenoptera in general, investigated both spermatogenesis and oögenesis. Possibly due to the unfortunate choice of technique, they neither confirmed Nachtsheim's finding of two groups of oöcyte chromosomes, nor did they perceive certain phenomena in the spermatocyte where chromosomes do actually lie in pairs and bud formation is as described by earlier investigators.

It was at this time, too, that the studies forming the basis of the present paper were broadening in scope to include not only the cytology and sex determination of the honey bee, but also its colour inheritance, its palaeontology, and its phylogeny. Only relatively brief statements reproductions of photomicrographs have so far been published (Manning, 1949). The cytological and palaeontological studies, however, are now at the stage when a synopsis of the first main results of this work can be presented. This is done in the following pages. Grateful acknowledgment is made to Prof. F. E. Zeuner who has undertaken direction of the palaeontological aspects of the studies and whose interest in the general work has been, for me, a source of much pleasure.

THE CYTOLOGY OF THE HONEY BEE.

Spermatogenesis. It will be recalled that, particularly for hymenopterons, the phenomenon of male haploidy is the rule. This implies the development of the male from the unfertilized egg, which thus possesses the haploid number of chromosomes. Several theories have been proposed to modify this concept. The latest is Whiting's, 1945, which advances the idea of variable numbers in the germ track for the purpose of restoring surface volume ratios. This, unfortunately, has not been observed in the honey bee, nor is it believed to occur in the manner Whiting postulates. Indeed, Whiting's theory was mistakenly based on certain erroneous conclusions of Nachtsheim (1913), particularly those involving the double value of chromosomes. With the rejection of the latter (Sanderson and Hall, 1948; Manning, 1949) so must Whiting's theory be rejected.

Maturation of the sperm, because involving the haploid number, is of necessity aberrant in type and consists of an abortive meiosis 1, and a meiosis 2 that brings about the fulfilment of meiosis 1. In essence it is a mere mitosis. but since there are present all the recapitulative stages of a meiosis a false picture is created if merely the former is stressed. Only one functional spermatid is formed, but there is a cytoplasmic elongation at meiosis 1 and the extrusion of a non-functional nucleated bud at meiosis 2.

The most important discovery was the existence of a morphologically distinguishable X-chromosome which is extruded, as a dyad, during meiosis 2. This means that the sperm pronucleus carries no X-chromosome. However, allowing for the haploid nature of the male honey bee, it also means that the fundamental process of sex determination for the latter creature falls into line with that of other organisms. This we shall see better after the discussion of oögenesis.

The well-marked association of chromosomes was also confirmed, and in this respect reference is made not only to the association of the two members of a dyad but also to the definite association in pairs of the dyads themselves. At first this was thought to be due to the attraction of fairly large heteropycnotic segments of chromosomes. Such a theory, however, does not fit the facts and the attraction is now considered to be mainly due to some remaining homology between the chromosomes themselves, in this case the direct result of polyploidy.

Oögenesis. The development and maturation of the egg, involving the diploid chromosome number, is on the whole fairly normal. The main interest centres on the continued polarization of chromosomes at diakinesis and also the failure of bivalents to open out to reveal chiasmata. It is thus not known whether the latter are indeed formed, which must mean, if cross-over does not take place, that heritable variability in the honey bee must be derived solely from multiple insemination. The theory of continued polarization is but little understood and cannot be discussed here, except to say that it was presented in a tentative manner for certain spiders by Revell (1947). One important difference, nevertheless, between the honey bee and spiders, apart from the fact that polarization for the former refers to oöcyte maturation and for the latter to spermatocyte maturation, is the fact that the chromosomes separate into two equal and constant groups in the honey bee compared with two unequal and numerically inconstant groups for the spiders. This for the honey bee not only gives a more realistic suggestion of anaphase but further supports the idea of some homology between chromosomes. Moreover, since a 30+1X chromosome complement *only* has been ascertained in the germ track of the female honey bee, a teleological argument can be used for the need of continued polarization. This, of course, is the necessity to retain the X-chromosome for the egg pronucleus so that the latter always inherently has the correct balance of autosomes to sex chromosome for the sex determination of the unfertilized egg, and fusion with the sperm pronucleus restores the correct balance for the appropriate sex determination of the fertilized egg.

Polyploidy. The main cytological statements of association of chromosomes during spermatogenesis and oögensis have been presented. The presence of polyploidy, however, was confirmed as a result of a cytological investigation of the stingless bees (*Melipona* and *Trigona* group), by Kerr, 1948. Here he found the male chromosome complement to number 9 compared with 16 for the honey bee. Since palaeontological evidence corroborates morphological and other evidence of the close relationship of the stingless bees and the honey bees, their dichotomy having occurred towards the end of the Eocene, this appears to imply that the stingless bees have subsequently added a monosomic to their basic chromosome number whereas the honey bees have doubled theirs. There are, again, other arguments (which unfortunately cannot be discussed here) that suggest 4 and not 8 as the basic number. With this in mind the chromosome formula for the stingless bees can be presented as $n=2x+1=9$ and for the honey bee as $n=4x=16$.

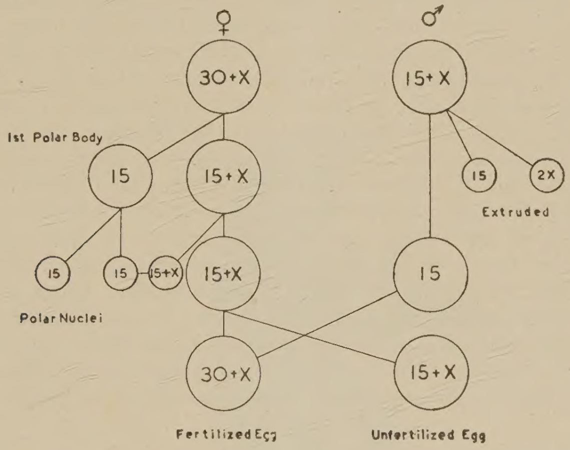


FIG. 1.—Plan of Sex-determination in the Honey Bee.

FOSSIL BEES.

Phylogeny and Evolution. The first records of fossil bees (apart from a comb structure from the Cretaceous, more probably the work of wasps) are from the Baltic amber, Upper Eocene. They present us with three main groups, (1) Andrenas, (2) some primitive forms referred to the Ctenoplectrinae, (3) primitive forms of modern Apinae (the latter in the limited sense of Michener).

Group 3 alone concerns us here.* On deductive grounds, there appears to be fair evidence that the ancestral form of the Apinae existed slightly prior to or in the Lower Eocene. Between then and the Upper Eocene the three tribes of Apinae, i.e. Bombini, Meliponini and Apini, emerged. (No fossil Euglossini are known, so that this tribe is omitted from the discussion). The inter-relationships of the known fossil forms leading to this conception are, on the whole, reasonably clear and it is important to realize that all specimens,

* Since this was written further material from the Roussy Collection, Switzerland, and particularly from the Scheele Collection, Geologisches Staatsinstitut, Hamburg, has been studied. This will necessitate certain modifications affecting, *inter alia*, the precise status of the genus *Chalcobombus* and provide more detail of previously known genera and species.

without exception, have a wing venation which is more or less Bomboid though no genuine primitive Bombini have yet been recovered from the Baltic amber. This is regarded as a mere misfortune of non-recovery. The separation into tribes is based on various morphological characters, of which the most important are those of the hind leg and the finer details of forewing venation.

The most undifferentiated genus and thus presumably the oldest is *Chalcobombus*. This genus, however, is more recent than any primitive member of Bombini could have been, but is clearly an ancestral form from which the primitive members of both the Apini and the Meliponini could have arisen. It is thus believed to have been itself a product of a dichotomy from the ancestral form of the Apinae, which somewhat earlier had produced the first Bombini, while its own dichotomies gave rise on the one hand to the primitive members of Apini and on the other to those of Meliponini.

All primitive Apini are members of the genus *Electrapis* which is a homogeneous group consisting of two subgenera and seven species. Among the latter, a new species from the amber collection of Mr. Bursey is considered to be the direct ancestor of the honey bee.

Known primitive Meliponini, in contrast to known primitive Apini, are scarce. The genus *Sophrobombus*, however, shows not only the reduction in wing venation but also a relatively long hind tibia and hairy scutellum. It may well have been a primitive member of Meliponini and it certainly indicates how the primitive members of this tribe could have arisen from a *Chalcobombus*.

The subsequent histories of these tribes are known, to varying extents, from later fossil forms ; the Bombini from the Miocene strata of Europe and America, the Meliponini from the Miocene amber of Sicily and the Pleistocene copal of Burma and E. Africa, the Apini from the Oligocene and Miocene strata of Central Europe and the Pleistocene copal of Africa. All these forms are well developed and nearly or quite 'Recent' in their characters. The Apini are by far the most numerous and specimens from the Rhine valley and the Swabian Alb number well over one hundred. From a study of them it is rather interesting to find that between the Upper Eocene and the Upper Oligocene all the main characters of modern forms had evolved and that by the Miocene the identity with modern forms appears to be almost complete.

This raises some very important evolutionary points which can be stated as follows :—

(1) Only a limited time was needed for the emergence of the tribes of Apinae.

(2) Speciation may, at first, have been fairly rapid.

(3) A comparatively enormous change in external form occurred in honey bees between the Upper Eocene and the Upper Oligocene.

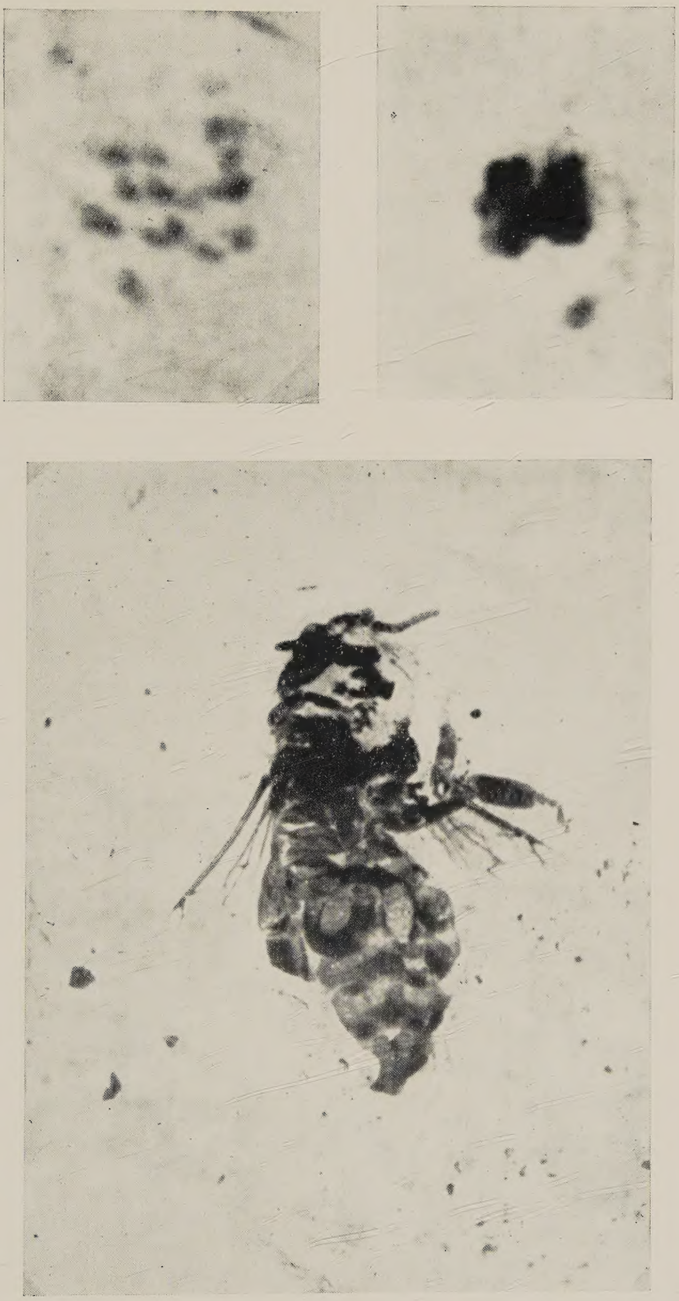
(4) There was great constancy of form over a long succeeding geological period of time (from Miocene times to the present day).

The above evolutionary phenomena can be accounted for according to the known mechanisms of species formation and theories of genetics. The arguments used to explain them can be summarized as follows :—

(1) The rapid emergence of the tribes of Apinae may have been primarily due to the establishment of a genetic system that offered increased opportunities for a new mode of life, e.g. social life based on the exploitation of flowers. This, though the intimate details of the process are not clear, might lead to diversification of form as a result of the altered rates of operation of the various evolutionary factors. The latter would work in a changed set of conditions.

(2) Rapid speciation offers two aspects deserving notice :

(*a*) the effective breeding population involved in early bee populations may have been small since some form of crude caste system may have delegated the breeding initiative to a comparatively limited number of queen mothers. In this case, the scatter of variability and the random variations of gene



RECENT AND FOSSIL BEES.

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frequencies may have become very important evolutionary agents, so much so that mutation pressure and selection in themselves may temporarily have lost their effectiveness. This random loss and fixation of genes endows evolutionary change in such small populations with a much greater rapidity of action.

(*b*) Since geographical isolation leading to a possible block to breeding is not so important in forms that may have been able to maintain themselves to some extent by means of both male and female parthenogenesis, this need not be postulated for special formation in the Apinae. Mutants in such parthenogenetic forms, can multiply, after their viability has been tested in the male, to form a small colony in which cross-fertilization may later be resumed.

(3) The large morphological change in honey bees between the Upper Eocene and the Upper Oligocene may well have been due to polyploidy. In this case the change would occur in a sudden leap.

(4) The constancy of form maintained after the Oligocene may have been due to the secondary effects of polyploidy which must have somewhat curtailed further evolutionary change since recessive mutants would have their phenotypic expression seriously delayed. However, since it is reasonable to suppose that later there emerged chromosome sets in the honey bee which had now become partly distinct as a result of the loss of much allelism due to mutation, the above explanation would become increasingly unsatisfactory. It is not unlikely, therefore, that the whole concept of constancy of form is somewhat deceptive since the evolution of the social state of the honey bee may not necessarily have entailed great morphological change of the workers. Indeed, it is well known that physiological change cannot always be identified with morphological change and the former may have occurred to some extent at this stage in the evolution of the honey bee. The complete answer to this problem, however, should involve a discussion of caste. Unfortunately, space does not permit this, except to mention the work of Kerr (1948, 1950 *a*, *b*) in which a genetic mechanism is suggested for caste determination in the genus *Melipona*.

(5) There is for most organisms an intrinsic as well as an extrinsic environment, the former the ' little world ' a creature creates for itself as a result of its nervous and 'psychological' make-up, and particularly its habits. Translated into terms compatible with the honey bee this refers to its colonial life. Moreover, the queen mother, the breeding unit, here comes considerably under the influence of this intrinsic environment. In so far as selection must operate through it, the latter, i.e. selection, may function mostly at a somewhat different level than is normal. To put this another way : the tendency of the hive-environment is to become more and more uniform and stable so that selection operating within it becomes more and more biased. However, in addition to this (and here it must be remembered that there is no reason to consider mutation frequencies in the honey bee as exceptional), unfavourable mutant genes are to some extent eliminated through the haploid male and also aberrant phenotypes are mostly rejected from the hive by the workers themselves. The result is a considerable reduction of variability within the population. This may be further accentuated by the possible failure of the occurrence of cross-over although relieved to some extent by multiple insemination. Since, therefore, most mutations are either not injected into the population at all or if injected are quickly removed save the ones which are non-harmful, and since the spread of such mutations is by a rather unorthodox method, the nett result appears to be a canalizing of the evolutionary momentum for the specific needs of a rigorous social life.

EXPLANATION OF PLATE 1.

1. Association in pairs of the dyads during early meiosis 2.
2. X-chromosome during its extrusion at early anaphase, meiosis 2.
3. *Apis* (*Synapis*) *henshawi* Cockerell. A fossil honey bee from the ' brown-coal ' of Rott am Siebengebirge, Upper Oligocene. Statz collection.

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Prof. J. MCLEAN THOMPSON. A Contribution to our Knowledge of Cauliflorous Plants: the Cannon-Ball Tree (*Couroupita guianensis* Aubl.). (Discussed by Mr. I. H. Burkill, Prof. F. G. Gregory, F.R.S., Dr. R. Melville, Dr. E. M. Delf and the President; Prof. McLean Thompson replied.)

Abstract,—

Although there have been readings of the cauliflorous state for more than seventy years, no proper means of judging them were sought until quite recent times. It is now known to be attained in diverse ways, a few of which have been disclosed within the past decade. The present statement concerns a forest tree whose flowering shoots are all endogenous within the cortices of limb and bole.

It was shown that, where these shoots can form, a mass of cortex had become a field with scattered groups of cells which organize as round or oval meristems. A single meristem may then acquire ascendency within a region of this field, and later yield the apex of a shoot which will be brought to flower. In this event, each meristem within the minor field becomes a focal point from which a 'prophyll' will be formed within amorphous cortex. These prophylls will be freed, in time, along their greater lengths; and, when at last exposed, will each subtend a bud which is its focal meristem transformed.

There may be two or more than two ascendent meristems within a minor field; and each may then become the apex of a shoot which can be brought to flower. In this event, each shoot deprives its neighbours of potential prophylls and their buds; and any shoot may later gain ascendency and be alone exposed.

The shoots themselves are in somatic state when freed, at last, from covering cortex and from ruptured bark. Their flowering time begins, when fully exposed. And when they fall, still deeper groups of scattered meristems are formed and thus prolong the flowering phase on limb and bole alike.

[To be printed in full in Part 2.]

PROCEEDINGS OF THE GENERAL MEETING ON 23 November 1950

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 26 October 1950, having been circulated, were taken as read, and confirmed.

The President read a message of condolence with HIS MAJESTY KING GUSTAF VI ADOLF OF SWEDEN, all present standing in their places.

To—

HIS MAJESTY THE KING OF SWEDEN AND OF THE GOTHS AND THE WENDS.

MAY IT PLEASE YOUR MAJESTY.

The Fellows of The Linnean Society of London desire to tender their most profound and respectful sympathy with Your Majesty and the Royal House of Sweden on the irreparable loss sustained in the decease of HIS MAJESTY KING GUSTAF V.

Deriving our title and inspiration from one of the most distinguished sons of Sweden, the welfare of that country must ever be of interest to us, and we rejoice to recall the fact that His late Majesty King Gustaf was for over forty-two years one of the Honorary Members of The Linnean Society of London, and that in the year One Thousand Nine Hundred and Twenty-three His late Majesty further honoured the Society by visiting the Society's Rooms and inscribing his name in the Roll and Charter Book.

That Your Majesty may long be spared to see the nation under Your Government an increasingly prosperous people, is the fervent wish of this Society.

Dated the fourth day of November in the year One Thousand Nine Hundred and Fifty.

F. E. FRITSCH, *President.*
F. C. STERN, *Treasurer.*
B. BARNES, } *Secretaries.*
A. TINDELL HOPWOOD, }

The President announced that the Fellows of the Society were invited to send in nominations for the Officers, the Linnean Medallist (Zoologist), Foreign Members and Associates *honoris causa.*

The following were thanked for gifts made to the Library since the last Meeting :—Dr. G. C. Ainsworth, Dr. F. Børgesen, Dr. H. C. Cameron, Mr. N. I. Hendey, Dr. John Hutchinson, F.R.S., Dr. E. E. Sherff, Mr. F. A. Sowter, Prof. F. E. Weiss, F.R.S., the International Council of Scientific Unions, and the University of Birmingham.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Mr. Gordon Edgar Barnes, Mrs. Ellen Hazelwood and Mr. Francis Philip Knight.

DISCUSSION MEETING : 'WHAT IS MAN ?'

(Plate 2.)

The Discussion was opened by Prof. E. C. AMOROSO, Prof. A. J. E. CAVE, Dr. W. C. OSMAN HILL and Dr. A. TINDELL HOPWOOD.

The following also took part—Dr. L. S. B. Leakey, Dr. Malcolm Smith, Lieut.-Col. W. P. C. Tenison, D.S.O., Prof. F. E. Weiss, F.R.S., Prof. W. J. Hamilton, Dr. Errol I. White, Dr. W. B. Turrill and the President.

DR. A. TINDELL HOPWOOD : Physically, man is a large, naked, erect, bipedal primate with a big brain, but, as Huxley pointed out in 1863, it is not easy to discover absolute anatomical differences between a man and a gorilla. In 1898, Haeckel suggested that man is to be distinguished from the apes by his buttocks and the calves of his legs. Both these features are associated with the maintenance of an erect posture, and because they are seldom discussed, I propose to deal with them here.

In a quadrupedal mammal the spine forms a shallow arch supported on double piers at either end. The neck projects beyond the front pair of piers, and the relatively long skull is hung on to the end of the neck. In the human subject the spine has two primary and two secondary flexures: the more or less globular skull is balanced on its tip, and it pivots on the femora by way of the innominate bones. Rotation of the spine relative to the femora is largely effected by the action of the glutaeal muscles.

In some quadrupeds (e.g. carnivores, monkeys) a small muscle, the m. glutaeus superficialis, passes from the sacrum to the femur, in others (e.g. cow) the muscle is absent, but in the human body its importance is very great and as the m. glutaeus maximus it is the biggest, heaviest, and coarsest-textured muscle in the whole body, forming the fold of the nates by reason of its size and weight.

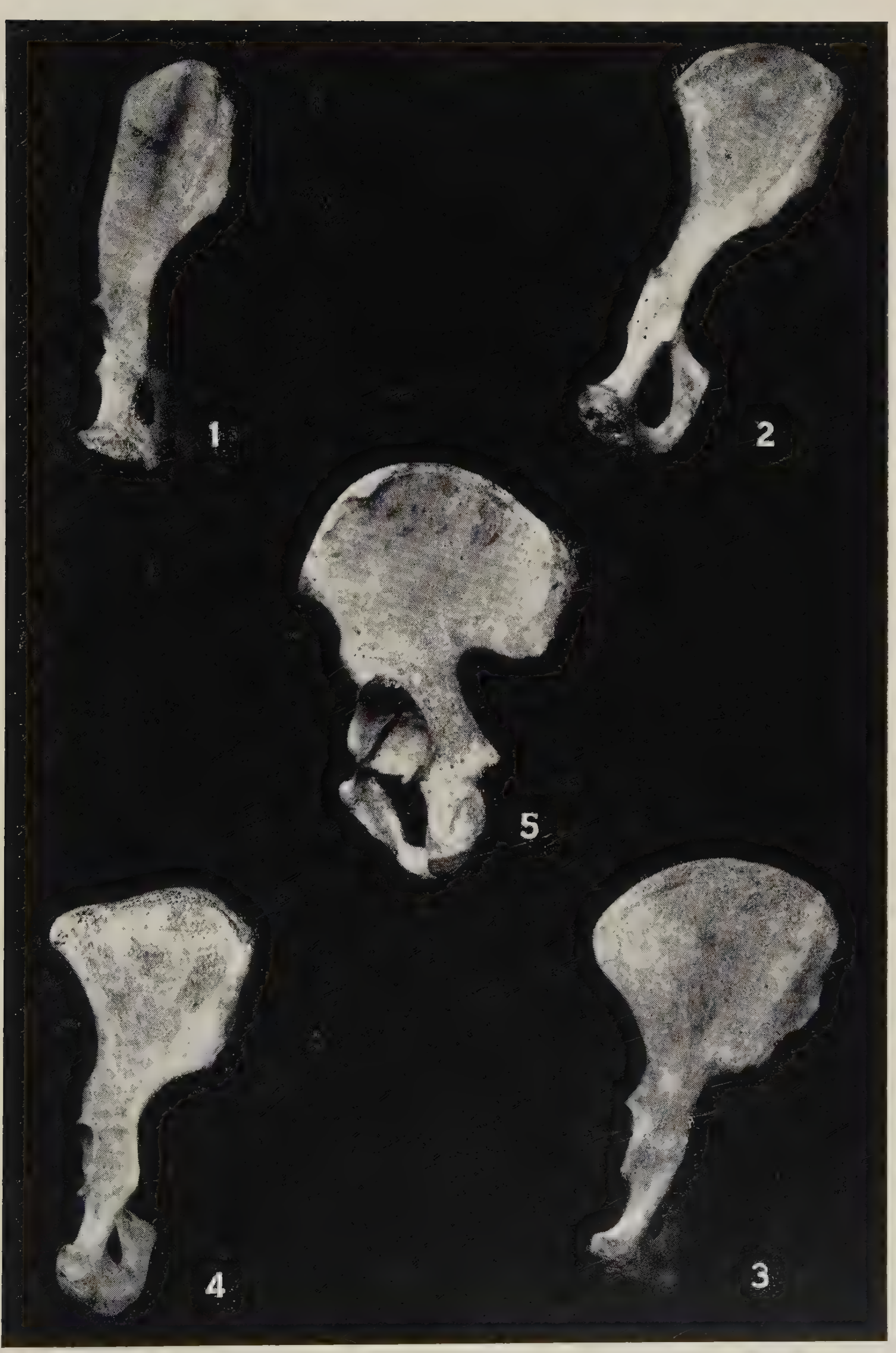
When the trunk is flexed on the thigh, contraction of the mm. gl. maximi rotates the pelvis on the heads of the femora and restores the trunk to the upright position. Conversely, if the pelvis is fixed and the thigh flexed on the trunk contraction of the muscles extend the thigh. At the beginning of either action the muscle passes downward and outward in such a way that it does not cover the tuberosity of the ischium: as it contracts it glides inwards and when the action is complete the tuberosity is covered. This gliding motion is not possible when ischial callosities are present because of the intimate application of the skin to the tuberosities; in other words, ischial callosities and a true glutaeus maximus are incompatible. Under such conditions rotation of the pelvis is effected by another muscle, the glutaeus medius. This underlies the m. gl. superficialis; it takes its origin from most of the blade of the ilium and inserts to the great trochanter of the femur. In gibbons the m. gl. medius is unusually large, but the arrangement is mechanically inefficient and maintenance of the erect posture is difficult.

The different dispositions of the soft parts are reflected in the structure of the bones that support them. The innominate bone of a gibbon has a narrow, blade-like ilium, an ischial tuberosity that is expanded transversely and flattened to accommodate the callosity, and an extensive ischio-pubic symphysis. It is typically quadrupedal, at least in the characters of the ilium and the symphysis.

In a chimpanzee the upper half of the ilium is expanded transversely, whereas the lower half is narrow as it is in the gibbons. The expansion affords a greater area of origin for the m. gl. medius, and the correspondingly longer iliac crest gives more room for the various muscles of the flank, as well as for the m. latissimus dorsi, which is relatively larger than it is in a man and not much smaller than that of a gorilla. The ischial tuberosity is less expanded and flattened than in the gibbon and is more dorsal in position, but it is large and reflects a close apposition of skin to bone despite the absence of an external callosity.

The ilium of the gorilla is flabellate, concave on its inner surface and convex on the outer. Its greater expansion not only affords more area for the origins of the mm. gl. medius et minimus but also carries the sacrum still farther away from the primitive position relative to the acetabulum that it retains in the gibbon. This shift in the position of the sacrum is also a change towards the conditions favourable to an upright posture because it tends to bring the centre of gravity of the head and trunk more nearly to a point over the pelvis and hind-limbs. The ischial tuberosity is not very different from that of the chimpanzee, and of itself is sufficient to show that the gliding action of the m. gl. maximus characteristic of man is absent from the movements of the m. gl. superficialis of the gorilla.

This last point is of considerable interest because the m. gl. superficialis is so well developed in the gorilla that it forms an incipient nates and could almost be termed a m. glutaeus maximus. Nevertheless, its bony attachments



INNOMINATE BONES OF HIGHER PRIMATES.

are different from those of a true m. gl. maximus. The proximal end arises from the neural spines of the sacrum ; there is no iliac origin but part of the lower margin takes its origin from the ischial tuberosity ; for this reason, if for no other, the muscle is unable to glide over the tuberosity. The lower end of the muscle inserts to the distal half of the femur by a linear insertion extending from a point about five inches below the great trochanter to the lateral epicondyle, whereas in the human subject the insertion is to the proximal third of the bone.

The innominate bone of the orang utan is more ' human ' in some respects than any of those just mentioned. For example there is a distinct anterior inferior spine and a well-marked, if wide and rather shallow, sciatic notch. The symphysis, too, is interesting. In the gorilla, as in the gibbon, it is of the ischio-pubic quadrupedal type, and the articular surface forms an angle with the inferior border of the innominate. In the orang utan and chimpanzee the articular surface curves into the inferior border and does not form an angle with it. That is to say, the ischio-pubic symphysis has opened at its caudal end to such a degree that only the pubes are in contact : this is the condition seen in man, but the extent of the contact is greatest in the chimpanzee, less in the orang utan and least in man. One may, perhaps, note that the orang utan, which has more 'human' or quasi-human features in its innominate bone than any other of the Ponginae, is also the most arboreal in its habits.

There is no necessity to consider the human os innominatum in detail ; it is familiar to all anatomists and is represented in fig. 5 of the plate. One of the most important points to remember is that the m. gl. superficialis, now the m. gl. maximus, has lost its ischial origin and acquired an iliac one instead ; consequently it is free to glide over the smooth, rounded, dorsally placed ischial tuberosity.

Adoption of the upright position has also had a profound effect on the anatomy of the leg. A bipedal gait means that the whole of the work is done by the hind limb, and the greater part by the muscles that extend the foot and flex the leg upon the thigh. One result has been the development of that typically human structure the calf of the leg, which consists of two muscles, namely, the m. gastrocnemius and, deep to it, the m. soleus. Both these muscles act as powerful extensors of the foot and furnish most of the energy required at the beginning of a step : this is reflected in their enormous development, and facilitated by the possession of a common tendon of insertion to the tuber calcis, the tendo Achillis.

A third muscle that is of interest, in that its fate has been the opposite of the two just mentioned, is the m. plantaris. This is an insignificant muscle arising from the lateral condyle of the femur under cover of the lateral head of the m. gastrocnemius : it forms a short belly which terminates in a very long, narrow, flattened tendon passing downward between the superficial and deep muscles of the calf, either to unite with the tendo Achillis, or to insert to the medial surface of the tuber calcis, or to blend with the internal annular ligament.

This muscle is absent from one or both legs in about seven per cent. of human beings and in about fifty per cent. of chimpanzees ; it has only once been recorded in an orang utan and never in a gorilla. On the other hand, monkeys and most lemurs, as well as certain quadrupeds (e.g. cat but not dog), have the m. plantaris well developed ; in them its tendon passes over the calcaneus to end in the plantar aponeurosis and the muscle serves as a flexor of the toes. In a man the aponeurosis is attached to the calcaneus and the muscle does not exercise its original function but serves as a weak flexor of the leg instead. Apart from this small point, the human leg, in so far as it retains a m. plantaris, reflects a former quadrupedal or at least pithecoid condition and is more primitive than the apes.

Finally, the bipedal gait of man has carried with it a reversal of the proportions of the limbs, a reversal well shown in the following table compiled from Huxley's essay ' Man's Place in Nature ' (1863).

	Vertebral Column	Arm	Hand	Leg	Foot
Orang utan	100	122	48	89	52
Gorilla	100	115	36	96	41
Chimpanzee	100	96	43	90	39
European ♂	100	80	26	117	35
Bushman ♂	100	78	26	110	32
Bushman ♀	100	83	26	120	32

To summarize. Any definition of Man must take into account the anatomical peculiarities briefly outlined above. It must include the possession of a true m. gl. maximus instead of a m. gl. superficialis and therefore of an iliac and not an ischial origin, as well as an insertion to the femur that is proximal and not distal. Moreover, it must be so drawn that any primate dependent on the m. gl. medius as the prime factor in attaining an upright position is excluded.

EXPLANATION OF PLATE 2.

Comparative external views of the left innominate bone in (1) *Hylobates hoolock*, (2) *Pan troglodytes*, (3) *Gorilla gorilla*, (4) *Pongo pygmaeus*, (5) *Homo sapiens*, Andamanese ♂

The bones are posed so that the plane of the ilium is perpendicular to the optical axis of the lens, and a line passing through the anterior and posterior superior spines is horizontal. The scales of reduction vary in order that the figures may be of approximately equal height and differences in size eliminated.

Professor A. J. E. Cave said: Aristotle defined Man as ' the rational animal ', a definition which stands. Human nature embodies therefore a combination of rationality and animality unique in all creation, and the rational component in his nature distinguishes Man from, as it elevates him above, all other animals. Being rational, Man possesses personality, i.e. of every human individual it may be premised not only *what* he is (i.e. a particular human being) but also *who* he is (e.g. Socrates, Galen, Alexander). Pertaining to the rational component in human nature are those distinctive attributes which constitute the true hall-mark of humanity, viz. self-conscious activity, the faculty of concepts (including a concept of self), free will, conscience and concomitant moral responsibility, the power to control instincts, the extension of self in the sustained seeking of perfection and the communication of thought by articulate speech. Man alone therefore is the religious, as he is the moral, the aesthetic, the political and the humorous animal. By virtue of his rationality Man alone is the tool-maker, the fabricator of weapons, implements, clothing and the like, and hence the master, rather than the slave, of his environment. Throughout human history, these attributes of rationality have been (and continue to be) the effective basis of human behaviour, transcending in importance the mere accidents of physical constitution, whether racial or individual. Withal, and in virtue again of his rationality, Man has an innate awareness of his own dependence and limitations, that is, he is imbued with natural religion. Hence in any assessment of this rational animal, concentration upon human animality to the exclusion of human rationality is illogical, unscientific and intellectually disastrous: Man is compounded of the two, which cannot be dissociated. Moreover it is pertinent to observe that the rational in Man is not of its nature subject to analysis by the disciplines of the physical sciences: its study pertains properly to philosophy and theology.

Man's animality is, legitimately, a subject for zoological investigation. Zoologically, Man is a Primate, though one of very peculiar form. The key to much of his anatomical constitution lies in his retention of a host of exceedingly primitive primate characters combined with an extensive elaboration of the central nervous system and a distinctive posture. Phylogenetically Man has avoided those specializations of cranial, dental and somatological components so typical of the platyrrhine, catarrhine and anthropoid ape stocks. The less specialized any Primate has remained during phylogeny the more ' human ' therefore does its anatomical constitution appear. The various known Primate radiations and specializations, whether recent or fossil, are all directed, in varying degree, away from the direct human line, and, despite periodic discoveries of fossils alleged to represent 'ape-men', nowhere is the gap bridged between the truly human and the non-human.

Man is distinguished from all other Primates by (1) his unique bipedal orthograde posture, (2) his characteristic external form, (3) the unspecialized genitalia of the two sexes, (4) his distinctive cranial constitution, (5) the absolute size of his brain and the structural complexity of his nervous system, (6) his lack of tactile vibrissae at any stage of development and, (7) his delayed maturation as evidenced by a protracted infancy and childhood.

Externally, the hindlimb is primitively longer than the forelimb : the entire sole of the foot is opposed to the ground and progression is by true walking. The normal stance is an upright one, with the head balanced upon the neck, not dependent therefrom. The body outline presents characteristic curves, due partly to skeletal and muscular peculiarities, partly to the development and disposition of subcutaneous fat, which, particularly in the female, assists largely in moulding the body's contour. Thus the calves and buttocks are prominent, as in no other Primate. The loin region is concave vertically, and the mid-dorsal line of the back is flat or concave. The occiput protrudes backwards beyond the neck musculature. The face is straight, i.e. is without any ' muzzle ', and the chin is prominent. The lips are provided with red margins of transitional skin : the nose is prominent : the philtrum, grooved in the midline, continues to a superior labial tubercle. The hand is characterized by the great complexity of its papillary ridges and the thumb (which reaches the middle of the first indical phalanx) is large and possesses a wide range of movement. The hallux is unopposable and the foot is arched. The male external genitalia lack any baculum and the form of the glans penis is distinctive. In the female, outer and inner genital folds are both well developed and the prepuced clitoris is ungrooved by the urethra. In neither sex does specialized ' sexual ' skin occur. The human hair is peculiar in that coarse hairs are confined to the cranial, pubic and axillary regions in both sexes and to the beard area in the male : the various hair-tracts are of characteristic pattern, that on the back being unique. Sinus hairs (tactile vibrissae) are unknown. The female is characterized by a permanent, well-developed ' bosom ' even in the non-lactating phase of the mammary gland.

Internally, the skull presents a small facial and a large cranial component : its vault is domed and devoid of lambdoid or sagittal crests : it is balanced upon the spinal column and not slung therefrom as in apes, so that the foramen magnum looks downwards and forwards. On analysis the skull is divisible into a retained, large, primitive chondrocranium associated with a harmoniously developed dermocranium. The facial skeleton is divisible into neurocranium (the nasal fossae) and splanchnocranium (jaw parts) whereof the latter, in striking contrast to other Primates, is the more reduced. Hence, in Man, the presence of broad, discrete nasal bones; the absence of an independent premaxilla ; the retention of a primitively large ethmoid ; the large share taken by ethmoid and sphenoid in the formation of the orbits and the cranial floor ; the wide spheno-maxillary fissure ; the general spheno-parietal variety of pterion ; the primitively wide interorbital region ; the unique profusion of ethmoidal air cells, and the short, non-tubular bony external auditory meatus, with its strongly developed vaginal process. The teeth present no diastema and the canines manifest no specialized projection above their fellows. The maxillary and mandibular premolar teeth are single- or double-rooted, not triple-rooted as in apes.

The vertebral column is characterized by permanent curvatures, associated with the unique human posture and gait. The sacrum is normally five-pieced and the coccyx four-pieced, both primitive features departed from in the anthropoid apes. The pelvis is characteristically wide, rounded and capacious in both sexes and the ischia are devoid of callosities. In the hand-skeleton, an independent os centrale is wanting and the pollex attains the midpoint of the proximal indical phalanx. In the foot-skeleton the first (sometimes the second) digit is the largest ; the hallux is non-opposable, non-prehensile and weight-bearing, and its metatarsal is bound ligamentously to its fellows. The hallucial metatarso-tarsal joint is flat, even in foetal life. The functional axis of the foot is the second digit, not the third as in sub-human Primates.

The brain attains a relatively enormous size and unparalleled structural complexity. The average volume is 1000–1500 c.c. as against the anthropoid ape average of 400–500 c.c. In its extensive association areas and complex fibre arrangements lies the physical machinery necessary to mental activity.

In these—and in other—points of structure, Man differs significantly from all other members of the order Primates : so that, to date, whenever fossil primate remains occur sufficiently complete to warrant a scientific diagnosis, there is little difficulty in assessing their human or non-human status. Equivocal fragments must remain equivocal for want of fuller evidence.

On the purely physical side of his constitution Man remains a very distinctive Primate form, taxonomically worthy of at least subordinal status. If his natural physiological activities (e.g. his faculty of articulate speech) be also considered, then he clearly merits separate ordinal status. Certainly, alike from the physical and the non-physical viewpoints, Man among mammals is a form unique.

Dr. W. C. Osman Hill : In the nature of things, if we are to accept the hypothesis of the descent of Man from a subhuman Primate, there can be no hard and fast division between the human and the prehuman. Darwin adopted this stand and many have followed him. But there *is* a useful purpose served in recognizing academically an evolutionary horizon at which the human status is definitely attained. Both philosophers and scientists have endeavoured to supply criteria for this level of attainment. Thus Schopenhauer postulated the exhibition of ' free-will ' as decisive, whilst the anatomist Bischoff attributed the attainment of self-consciousness as characteristically human. More commonly we read of the power of reason as specifically human, whilst in recent times the archaeologists supply the definition of Man as the tool-maker.

It will be noted that all the above criteria fall into the category of mental characteristics. They all serve to emphasize the attainment of a certain horizon of psychic development which enables Man to associate ideas in such fashion as to commune with himself, with his fellow-men, to ' put two and two together ', and further to eke out his dwindling physical defences by the compensatory use of extra-corporeal objects.

The physical basis enabling Man to exercise these psychic faculties lies is his brain, particularly in the so-called association areas in the pre-frontal, parietal and temporal regions of the cerebral cortex. His brain must, therefore, exceed a certain minimum in size and must also possess qualitative advances—particularly in the extent, deep connections and cross connections of the above mentioned areas.

Keith estimated that in ' crossing the Rubicon ' from apehood to manhood, Man's ancestors must have attained a cranial capacity of between 700 and 800 cubic centimetres before the brain was capable of manifesting normal human behaviour. The smallest known modern human brain (that of an Australian aboriginal woman) except for examples of microcephalic idiocy incapable of normal human behaviour has a capacity of 850 c.c., whilst the largest known brain in a subhuman Primate (the male gorilla) does not exceed 650 c.c.

Keith's dictum, however, would appear to fall in the face of recent evidence provided by Broom's estimate of his latest discoveries of imperfect crania of *Paranthropus*—one of the larger Australopithecinae. Of these Broom estimates the female as having a cranial capacity of 850 c.cs. and guesses the male had one of over 1000 c.c., thereby, in Broom's estimation, demanding human status for this otherwise very ape-like creature. But Broom loses sight of the qualitative demands. He admits the lack of forehead (and hence of pre-frontal expansion) in *Paranthropus*, and he also forgets to make allowance for the relative size of brain to body. These were clearly relatively giant forms and, like Neanderthal Man—only to an even greater degree—a large body demands a large brain—but that brain is mainly a somatic motor machine ; its psychomotive functions are limited. Though the Australopithecine brain undoubtedly points the way that the human organ took in its evolutionary progress, it had not yet attained that degree of associative power enabling its possessor to exhibit a human behavioural pattern.

Dr. L. S. B. LEAKEY : As more and more fossil material of the higher Primates comes to light, it is becoming increasingly difficult to define the term Man on the basis of morphological characters such as brain capacity, dentition, erect posture, etc. The position is likely to become still more difficult as new discoveries are made.

Therefore Man is defined as a tool-making mammal of the order Primates, and is taken to include members of any genera or species which can be shown on reasonable evidence to be tool-makers, provided that where fossil primate material is found which morphologically approximates to Man, but under conditions which do not indicate *per se* whether the creature they represent was a tool-maker or not, it is deemed sufficient to show that it does not differ significantly from fossil Primate genera or species already known to be tool-makers from the evidence of other sites, to warrant the inclusion of the new material provisionally under the term Man.

Thus the Mauer jaw and the *Meganthropus* jaw would be provisionally ascribed to Man, while the Australopithecinae would not qualify on the available evidence in spite of having some essentially Hominid characters.

The term ' Hominid ' as a scientific term must be kept clearly distinguished for Man, for the Hominid stem is likely to be traced backwards as is the stem until the two meet at some remote common starting point.

It is further suggested that the term *Homo* might be made synonymous with Man and regarded as the genus to which all Man belongs, with such generic terms as *Euanthropus*, *Eoanthropus*, etc. reduced to subgeneric rank.

This would appear to be more logical than the present position.

Lt.-Col. TENISON asked that as it was his impression that in estimating intelligence the convolutions of the brain were more important than its overall size—was it possible to deduce any evidence of the convolutions in the fossil man-like skulls ?

[Dr. L. S. B. LEAKEY replied that further study was required on recent human skulls with their brains preserved in spirit, and a large collection should be amassed.]

Professor WEISS said that he was surprised that none of the speakers had mentioned directly the erect stature of man, though the peculiarities of the pelvis referred to by Dr. Hopwood were of course connected with his upright posture. Was there a possibility that the latter influenced the development of the brain. This was not necessarily the case as there was no evidence that the brain of the kangaroo had been affected by the vertical carriage of the animal. But upright position of man had greatly influenced the character of his foot as Professor Wood Jones has shown in his *Hallmarks of Mankind*. The peculiar structure of man's foot is developed at a very early stage of the foetus, indicating that it was a modification of long standing. The anthropoid apes have a grasping hind foot and when walking put the edge of the foot on the ground. They put the knuckles of their hands on the ground when walking.

Prof. W. J. HAMILTON said that examination of the early stages of development of the anthropoid apes in so far as they have been studied, gives no help in determining the evolution of man ; but there were striking similarities in the definitive placenta of man and the anthropoid apes. The glutaeus maximus muscle was very large in man, but it was not actively contracting to maintain the upright posture.

Dr. ERROL WHITE remarked that the interest of the question 'What is Man ?' did not lie in the distinctiveness of *Homo sapiens* in the existing fauna, as most of the speakers seemed to suggest—the species was very clearly differentiated from its nearest existing relatives, and a large series of characters, including mental characters (which were after all manifestations of physical characters) could be listed from text-books and other readily available sources. In his opinion, the interest lay largely in question of where to draw the line in the series of supposedly related extinct types. In this the issue was always confused by prejudice owing to the fact that our own species was involved, but in fact the difficulty was purely a systematic one and cropped up when any series of apparently related fossils were studied, and usually resolved itself into a matter of personal opinion as to what constituted a certain systematic unit—and in this case to what unit the term 'Man' was to correspond. General agreement on any of these points was unlikely, for evidence on this point was always liable to be weighted by the special interest of the authority concerned.

Dr. W. B. TURRILL asked if there were many characters in man in a state regarded as more primitive than that of the homologous characters in the anthropoid apes. He also asked if there were any differences in the chromosome complements of man and the apes. It is generally stated that the male of the human species has $46+XY$ and the female $46+XX$ chromosomes. Apart from any numerical differences, are there any differences in size, shape, and behaviour in the chromosomes of man and apes ?

In concluding the Discussion, the PRESIDENT said that it seemed to him that the various speakers had tended to emphasize the differences between man and apes. Speaking as a botanist, he had always felt a great difficulty in agreeing that one group of plants had evolved from another, and that at the most one could say that a particular group had originated from an ancestry which resembled in many ways the members of the other group.

PRESIDENT'S RECEPTION

7 December 1950

The PRESIDENT, Professor F. E. FRITSCH, D.Sc., Ph.D., F.R.S., received the Guests in the Library.

Mr. JOHN CHEAR, F.L.S., showed a film of Scolt Head entitled 'Bird Sanctuary'.

EXHIBITS IN THE LIBRARY.

EAST MALLING RESEARCH STATION. Some seedling apples and their parents. (Shown by Mr. H. M. TYDEMAN and Mr. E. G. COKER.)

This exhibit consisted of nine baskets of apples arranged to illustrate the results of cross breeding between well known English and American dessert apples. Fruits of the varieties 'Laxton's Superb', 'Cox's Orange Pippin', 'Golden Delicious', 'McIntosh Red' and 'Worcester Pearmain' were shown with fruits of seedlings obtained by intercrossing them. These seedlings included a late maturing dessert apple of promise, 'Tydeman's Late Orange', the result of crossing 'Laxton's Superb' with 'Cox's Orange Pippin'; a brilliantly coloured Autumn eating apple, 'Martinmas', from a cross between 'McIntosh Red' and 'Worcester Pearmain'; an unnamed apple from a cross between 'Golden Delicious' and 'Cox's Orange Pippin' which appeared to combine the characteristic colouring of both parents and another unnamed apple from a cross between the two American varieties, 'Golden Delicious' and 'McIntosh Red', which showed the influence of the last named parent very markedly in the texture of the flesh and the characteristic red striping of the skin.

These fruits were produced at the East Malling Research Station in the course of apple breeding experiments carried out with the object of obtaining new and improved varieties.

BOTANICAL DEPT., UNIVERSITY COLLEGE, LONDON. *Mastigocladus laminosus*, a nitrogen-fixing alga of hot springs. (Shown by Dr. G. E. FOGG.)

Mastigocladus laminosus Cohn, a blue-green alga, isolated in pure bacteria-free culture from material obtained from the hot springs of Rotorua, New Zealand, has been shown to be capable of fixing the free nitrogen of the atmosphere. A culture of this alga in an inorganic medium containing no supplied combined nitrogen was exhibited together with microscopical preparations and a photomicrograph illustrating its morphology.

LINNEAN SOCIETY. A selection from the Collection of Engraved Portraits.

The Society's collection of engraved portraits of naturalists and of persons after whom genera have been named was begun with a bequest of 766 portraits under the Will of Lord Arthur Russell, a Fellow of the Society, who died in 1892. Considerable additions have been made to the collection since that date, mainly by the generous donations of the late Dr. W. Rushton Parker, F.L.S.

A selection of the portraits of eighteenth century naturalists was shown, including a very fine mezzotint engraving of the Dutch botanist N. J. Jacquin, (1727–1817) as an old man.

ZOOLOGICAL SOCIETY OF LONDON. Living tropical toads and frogs. (Shown by Mr. J. W. LESTER, Curator of Reptiles.)

Included in this collection were two species of *Dendrobates*, the Arrow Poison Frogs from South America. The skin secretion from these frogs is used by certain Indians to tip the heads of their arrows. Gadow in his book *Amphibians and Reptiles* (The Cambridge Natural History, vol 8, 1899), mentions that by removing head feathers from the Green Amazon Parrot and rubbing the bare flesh with this poison, the new feathers grow yellow.

Another South American species shown was the translucent *Hyla aurantiaca*. When this frog is held up to the light the skeleton and viscera can be clearly seen.

Other frogs exhibited were *Phyllomedusa hypochondrialis* also from South America, and a number of tropical African species including *Hyperolius marmoratus*, *Megalixalus fornasini*, *Hylambates maculatus* and *Phrynomerus* *bifasciatus*. The last mentioned, sometimes called the Orange-banded Wood Toad is strikingly coloured and has the habit, when annoyed, of lifting up its rear portion, which is swollen in appearance, and walking backwards. It can even do this on a vertical surface.

BRITISH MUSEUM (NATURAL HISTORY). (1) Eustachian sacs of Dolphins; (2) Comparison of parts of the Cetacean skeleton with that of normal land mammals. (Shown by Dr. F. C. FRASER.)

Prof. G. D. HALE CARPENTER, M.B.E. Geographical variation in *Euploea* spp, from the South Pacific.

Professor G. D. Hale Carpenter exhibited a series of the butterfly *Euploea boisduvalii* Lucas, 1853, from the Oxford University Museum by kind permission of Professor G. C. Varley. This polytypic species appears to have developed in the Solomon Isles from *E. duponcheli* Boisduval 1832, of the Moluccas. Neither species occurs in New Guinea or the Bismarck Archipelago. *E. boisduvalii* has spread to the south-east as far as the easternmost Fiji islands (Lau Archipelago) but has not overstepped the continental shelf. It varies remarkably in size: the forms on the various islands of the Santa Cruz group, in New Hebrides, New Caledonia, and the Loyalty Islands, being much smaller, while the Fiji specimens are like those of the Solomons in size. White-bordered forms in Maleita, and the easternmost of the Solomon Isles, appear to be synaposematic with other species similarly marked. The strikingly white-spotted form from Western Fiji is synaposematic with a species of different affinities in the same area, while the Eastern Fijian form is very dark and differs little from the usual Solomon Islands representative.

COUNCIL FOR THE PROMOTION OF FIELD STUDIES. Photographs of Field Centres and illustrations of some of the work carried out in the Centres.

Photographs were displayed showing the great diversity of environment at the Council's four Field Centres :—Flatford Mill, on the estuary of the river Stour; Juniper Hall, amidst the chalk hills of Surrey; Malham Tarn, on the limestone uplands of the Yorkshire Pennines; Dale Fort, built into the Old Red Sandstone cliffs of the Dale Peninsula, Pembrokeshire, with Skokholm Island Bird Observatory lying some three miles out in the Atlantic.

Examples of investigations carried out at the Centres were shown. A chart recorded changes in plant distribution induced by changes in salinity of a hitherto brackish stream, caused by the building of a new sluice gate near Flatford Mill. A vegetation map showed the results of a survey of the Box Hill Estate by a group of University students, while a relief model and geological map of the same area provided added interest. Many colour photographs taken near Juniper Hall showed examples of the local flora and fauna; these included *Thesium humifusum* DC., *Herminium monorchis* Br. and *Ophrys muscifera* Huds., while among the fauna was *Helix pomatia* L., typical of only some chalk areas. There were also pictures of badger setts, sunning beds and tracks. An intensive piece of research on the vegetation of Skokholm was illustrated by a detailed vegetation map of the Island. Many photographs of rarities of the Malham flora included *Arenaria gothica* Fr., *Actaea spicata* L., *Bartsia alpina* L. and *Polemonium caeruleum* L.

ROYAL HORTICULTURAL SOCIETY. Botanical drawings by (1) Miss DOROTHY MARTIN; and (2) CLAUDE AUBRIET (1665–1743).

(1) Water colour Drawings of British Plants by DOROTHY MARTIN.

The four large illustrations shown portrayed in colour *Sedum album*, *S. acre*, *S. anglicum*, *S. Fabaria* and *S. Telephium*, *Lamium album*, *L. purpureum* and *L. Galeobdolon*, *Nymphaea alba* and *Agrostemma Githago* (*Lychnis Githago*).

They form part of a large collection painted by Miss Dorothy Martin (1882–1949), who was for thirty years art mistress of Roedean School; they were presented by her sister to the Lindley Library in 1950.

(2) Ink and Wash Drawings of Plants by CLAUDE AUBRIET.

The illustrations shown portrayed *Adiantum Capillus-Veneris, Anemone Hepatica, Dracunculus vulgaris, Geranium Robertianum, Paeonia mascula, P. officinalis, Punica Granatum, Tamus communis, Tropaeolum majus, T. minus, Tussilago Farfara, Zea Mays.* They form part of a large collection of drawings by Claude Aubriet (1665–1742) bequeathed to the Lindley Library by Reginald Cory. The full history of these little drawings is unknown but it seems probable that, although never published, they were intended to illustrate a work by Antoine de Jussieu (1686–1758), perhaps his posthumous *Traité des Vertus des Plantes* (1771). They bear pre-Linnaean names as used by Tournefort, together with some Linnaean names added by a later hand, perhaps by Lamarck.

LINNEAN SOCIETY. Manuscripts from the Society's miscellaneous collection by (1) GIDEON A. MANTELL, F.R.S., F.L.S. (1790–1852); (2) F. H. L. MARTINI (1729–78); and Col. GEORGE MONTAGU, F.L.S. (1751–1815).

(1) Gideon A. Mantell's MS. of his paper on a fossil Alcyonium, published in the Society's *Transactions*, with coloured illustrations by G. Chassereau, 1814.

(2) Martini's MS. of his *Conchylien-Cabinet*, 1769, 1773 and 1777, being the actual one from which the work was printed.

(3) Montagu's MS. of his *Testacea Britannica*, together with some of his note-books. The illustrations are by Eliza Dorville.

ROYAL BOTANIC GARDENS, KEW. (1) Original paintings prepared for The Botanical Magazine. (Shown by Dr. W. B. TURRILL); (2) Original paintings of Fungi. (Shown by Miss E. M. WAKEFIELD, O.B.E., and Dr. R. W. G. DENNIS.)

(1) *Botanical Magazine.* Dr. W. B. Turrill exhibited for the Royal Horticultural Society and the Royal Botanic Gardens, Kew, a series of forty-four paintings of living plants. These have been selected for publication in the 1952–3 volume of the *Botanical Magazine.* The artists whose work was represented are Miss L. Snelling, Miss S. Ross-Craig, and Miss A. Webster. The plants figured included trees, shrubs, and herbs from many parts of the world cultivated as hardy or tender plants in this country.

(2) *Original paintings of Fungi.* These are the originals of the plates recently published in *Common British Fungi*, by Miss Elsie M. WAKEFIELD, O.B.E., M.A., and Dr. R. W. G. DENNIS.

PROCEEDINGS OF THE GENERAL MEETING ON 4 January 1951

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 23 November 1950, having been circulated, were taken as read, and confirmed.

The President read a reply to the message of condolence sent to HIS MAJESTY KING GUSTAF VI ADOLF, on the death of HIS MAJESTY GUSTAF V, KING OF SWEDEN, K.G., Honorary Member of the Society.

The following were thanked for gifts made to the Library since the last Meeting :—Dr. A. C. Hazevoet, Mr. Richard Morse, Mr. F. J. Reed, Dr. W. G. Templeman, Prof. F. E. Weiss, F.R.S., the British Society for the History of Science, the Trustees of the British Museum, the Carnegie Institution of Washington and the Royal University, Uppsala, Sweden.

The following signed the Obligation in the Roll and Charter Book, and were admitted Fellows :—Dr. M. C. Helen Blackler, Dr. Sheila M. Lodge, Mr. Peter Karel Sartory and Dr. William A. Clark.

The President reported the deaths of Prof. William Thomas Gordon, Mr. William Percy Jones and Mr. Pierre Elie Félix Perrédès, Fellows of the Society.

The following communications were read and discussed :—

Dr. MARGARET T. MARTIN and Dr. MARY A. POCOCK. Some South African Parasitic Florideae. (Discussed by the President, Dr. E. M. Delf and Dr. Sheila Lodge ; Dr. Martin replied.) [To be printed in the Journal, Botany.]

Discussion,—

The PRESIDENT congratulated Dr. Martin and Dr. Pocock on the extensive survey of parasitic Florideae on South African shores which they had undertaken. He hoped that by degrees the British forms would be as completely studied and, in this connection, had been pleased to hear Dr. Martin speak of abundant material of *Gonimophyllum* obtained from Anglesey. One of the most striking features of this series of forms was that they were practically all parasitic on members of their own class and usually on very closely related forms. He believed that scarcely any of the truly parasitic Florideae had ever been found on algae belonging to other classes.

Another matter of interest was that apparently the parasite never did any serious harm to the host, and he would like to know whether Dr. Martin had ever noted any appreciable weakening of the latter. The establishment in several instances of connections between the endophytic threads of the parasite and the cells of the host was of importance. He believed that Rosenvinge had already recorded this for *Choreocolax*. Dr. Martin's reference to the presence of galls on *Rhodomelopsis* led him to enquire whether, in the course of this extensive investigation, they had met with many examples of such galls which he believed were generally supposed to be caused by bacteria, and whether they had found much evidence of fungal attack.

Dr. E. M. DELF commented on the acute observation needed to detect such minute parasites and on the skilful technique needed to investigate them.

She pointed out that there is no sharp distinction between epiphytism and partial parasitism in marine algae. *Polysiphonia lanosa*, for example, is often regarded as epiphytic on *Ascophyllum nodosum* but is probably parasitic since penetration of its filaments into its host seems necessary for full development, independent plants being rare and dwarfed.

The host-parasite relationship has scarcely been investigated in the marine algae, but wherever the parasitism is extensive and frequent (as in *P. lanosa*), we may expect physiological and biochemical changes in the host which may well be of significance in marine plants from which commercial products are derived.

Penetration of parasitic algal filaments into living cells of the host has been seldom recorded, but appears to be characteristic of the examples described. It would be of interest to know whether haustorial swellings are also formed, such as are frequently found in parasitic fungi.

Dr. SHEILA M. LODGE said that parasitic red algae do not appear to weaken their hosts, for example *Callophyllis laciniata* and *Cryptopleura ramosa* heavily infested with *Callocolax* and *Gonimophyllum* respectively are frequently found in the Isle of Man. Yet such fronds are indistinguishable in colour and consistency from uninfested fronds growing nearby. Attacks by Chytrid fungi, however, have been observed to destroy young fronds of *Codium* and to hasten the disintegration and disappearance of *Tilopteris Mertensii* and *Dumontia incrassata* at the end of their growing seasons.

In answer to questions, Dr. MARTIN replied that examples of Floridean parasites on hosts other than members of the Florideae were very rare. So far as could be seen, the parasites described did not cause any appreciable weakening or diminution in vigour of the host, nor did they, at any rate for some length of time, kill the host cells with which they made connection. Adjacent pustules were sometimes the result of separate infections, but undoubtedly they could also arise from underlying parasite filaments which ran beneath the surface of the host and produced successive aerial branches. During the course of this investigation, fungal parasites had been found on various red algae, as had also galls which were possibly bacterial in origin.

Dr. H. CHARLES CAMERON. Some new light on Sir Joseph Banks. (Discussed by Col. F. C. Stern, O.B.E. and Mr. W. G. Mackenzie.)

SOME NEW LIGHT ON SIR JOSEPH BANKS

By Dr. H. CHARLES CAMERON.

In the eighteenth century there was no one quite like Sir Joseph Banks. In a world which seemed to his contemporaries to have attained a development almost incapable of improvement, he looked forward only to new departures. His voyage on the *Endeavour* with Captain Cook was no mere adventure of his youth, dared and done with; nor did it result solely in the advancement of the science that he loved. All Captain Cook's voyages achieved great results, but the voyage of the *Endeavour* was big with importance for the future because in Banks, the little ship carried on board perhaps the one man in all England who could foresee its implications and develop its consequences. To Banks exploration was but a preliminary to colonization of the lands discovered. It was he who drew up the 'Heads of the Plan' for the settlement of New South Wales and when, from the neglect of the Government, fully occupied with the deadly struggle against Napoleon, the expedition nearly perished miserably in the wilderness, it was he who wrote* to the desponding Governor Hunter to be of good cheer, 'I see the future prospects of Empires and Dominions which now cannot be disappointed. Who knows but that England may revive in New South Wales what is sunk in Europe ? '

In the same way for Banks to be a botanist was to be immersed in gigantic schemes for the cultivation and interchange of plants from all quarters of the globe and every dependency of the Crown. It is to Banks that we owe the establishment of the traditions which have ever since inspired the work at Kew Gardens. For the Royal Gardens at Kew every part of the globe was searched. Any plant was an object of interest to Banks, but a plant that gave promise of being useful to mankind was something to be exploited at whatever cost to himself of time, labour and money. In every land his collectors travelled. In turn Masson, Ledyard, Caley, Menzies, Mungo Park, Bligh, Flinders, Robert Brown, and a host of others owed their opportunities to his constant support.

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* Dawson Turner Copies, X^2, 94.

But Banks was also owner of a great estate and for him to be a sheep farmer was at once to find himself involved in vast schemes, never attempted before, for the improvement of the native stock. By ways known only to himself and kept a close secret even from his partner in the enterprise, King George III, he succeeded in 1787, the year before the foundation of New South Wales, in securing for His Majesty a little flock of the jealously guarded Merinos of Spain, despite the strict laws which forbade their export. When later in the Peninsular War, the estates of the Spanish grandees, the owners of the finest merino stocks, were overrun by the revolutionaries, acting in concert with Sir Arthur Wellesley, these men were in a position to give to their allies large flocks of merinos of the finest breed and Banks had them shipped home in the transports returning empty from the seat of war. Very soon he was engaged in sending some of them on an even more adventurous journey to New South Wales. Thus for the great industry of Australia, wool, it was Banks too who was to some extent responsible. To this day in Camden Park near Sydney, a little flock of pure bred merinos, direct descendants of Bank's sheep, still crops the fine pasture, a race of aristocrats kept apart from all common sheep.

For no less than forty-three years he presided over the Royal Society. A magnificent figure in Court dress girt with the red ribbon of the Order of the Bath, he dominated the philosophers as, long ago, he had dominated the natives of Tahiti and New Zealand. To question his rulings or dispute his arguments, to encounter the formidable lowering of his massive eye-brows and the heave of his great body as he turned to face the disturber of the peace, with every year that passed, became a more alarming proposition, seldom adventured. By the end all opposition was silenced and his re-election had grown to be a mere formality.

With all this and much else accomplished Banks might seem to have deserved enduring fame. Yet to-day it would be hard to find anyone of like stature in his own age of whom less is now known. For this neglect there are two very obvious reasons.

In the first place there is the failure of nearly all his contemporaries to put upon record their first-hand knowledge of the man and of his work. After his death his trustees did indeed make several attempts to induce someone well qualified for the task to write the Life which all desired to see completed. The great mass of memoranda and correspondence which together with his Journals of the Voyages he left behind him in the most perfect order were in turn placed in the hands of Robert Brown, Dawson Turner and Charles Bell. Yet it was completed by none. Each on one excuse or another, returned the material and desisted from the great task. In his day Banks's rule over the men of science was as absolute and unquestioned as was that of Dr. Johnson's over the men of letters. The pity is that for him there was no Boswell.

To the silence of his contemporaries there is but one notable exception. Sir Everard Home, the first President of the Royal College of Surgeons, when he came to deliver his Hunterian Oration, took the unusual course of devoting it almost wholly to an eulogy of his dead friend. He did something even more unusual. He interrupted the flow of his oratory, in the manner of the time, to give in simple words his memories of intimate talks with Banks. In this forgotten oration :—it has been overlooked by all Cook's and Banks's biographers and copies of it are so rare that there is none in the British Museum —Home records some things that Banks told him which find no place in the Journals of the Voyage. Of the supreme moment of danger, when Cook's little ship, the *Endeavour*, crashed upon the coral reef, there is a graphic picture. All took their turn at the pumps, Banks with the rest, but as the hours passed and the men grew more and more exhausted in the sweltering heat, each relay could perform the tremendous labour for no more than five or six minutes at a time. Then every man threw himself down in the cool water which—to a depth of three or four inches—was pouring over the decks from pumps which never ceased. At the depressing moment when the seaman measuring the depth of water in the hold and not understanding his instructions made his miscalculation, Home tells us that Banks was off duty and asleep. But as the ill-omened cry rang out, 'Five feet and three inches of water in the hold', he awoke with a start fully conscious of its dire import, although so deep was his sleep that he doubted if a cannon-shot would have disturbed him.

Among the incidents of the voyage which Home alone records is the story of a remarkable escape which illustrates Banks's power over the natives. A party of Maoris suddenly sprang upon Cook, Banks and Solander, as they landed from their boat, seized them and with their arms twisted behind their backs began to force them towards the woods. Banks, refusing to allow Cook to make any resistance, exercised his strange power. Suddenly the native became fearful, hesitated, let go their hold and fled, leaving all three unharmed. It was Banks alone who could always allay the unreasoning terror or anger in the minds of suspicious savages. It makes one feel that had he been with him at the end Cook might perhaps have escaped his death on the shores of Hawaii.

In the second place, to the unfortunate silence of almost all his contemporaries there must be added the dispersal and loss of all the documents which alone could furnish the material for a complete biography. In the year 1873, the life still unwritten, the documents had been deposited in the Manuscript Department of the British Museum, but in 1886 Lord Brabourne, the grand-nephew of Lady Banks, asserting his claim to their ownership, removed them and sold the entire collection by auction at Sotheby's. There was but one redeeming feature in the disaster. Dawson Turner at the time that he was contemplating writing the Life had induced his daughters in their beautiful copperplate handwriting, to make a copy of Banks's Journal of the *Voyage of the Endeavour,* and of much of the correspondence. These copies were housed separately from the rest in the Botanical Department of the British Museum, escaped Lord Brabourne's observation, and still remain on its shelves in twenty great volumes. When a part of the Journal, one hundred and twenty-eight years after the Voyage and ten years after the auction, was first published in 1896, with Sir Joseph Hooker as its editor, it had to be printed not from the original manuscript, which was then missing, but from the beautiful copy made by Dawson Turner's daughters—the aunts of the editor.

From the fragments which remain it is a hard task to reconstruct for ourselves the figure of this broken Colossus ; yet enough remains to make the attempt worth-while. Much has been recovered after long search and is to be found to-day in Australia, especially in The Mitchell Library in Sydney, in America and, in this country, at Kew, here in the Linnean Society, in the Royal Society, in the Record Office, in the Royal Archives of Windsor as well as in private collections, notably in that of Mr. Warren Dawson, the bibliographer of the Linnean Society's collection of Smithian correspondence.

In the Royal Society, especially, there is a great store of unpublished documents, many in Banks's untidy hand, memoranda, drafts and rough copies of letters, notes and jottings of all sorts. Sometimes to-day the only evidence that remains perhaps of some important intervention by Banks with the Government is a rough scrawl recounting his advice or reply upon a half sheet of notepaper. Recently too the Royal Society has become possessed of a series of letters written over a period of more than forty years by Banks to his friend Sir Charles Blagden. The corresponding letters by Blagden to Banks have also been recovered up to the year 1805 and are in the British Museum.

From all this litter of papers—transcripts, letters and memoranda, rough notes and draft of replies—what emerges? Something very different from the tradition which has come down to us of the Autocrat of the Philosophers, of a man self-sufficient and tyrannous, proud, vainglorious, and not a little puffed up by the honours conveyed to him by a King with whom he made it his business to stand well. Even when the comment is not adverse, it is usually but lukewarm in his praise.

For instance, in the published correspondence of Sir Joseph Hooker, as might be expected, the name of Banks crops up from time to time. On its first mention, the editor, Leonard Huxley, adds a footnote, typical of the common appraisement of the man.*

> ' Sir Joseph Banks (1743–1820) became a botanist in a burst of schoolboy enthusiasm. His ample inheritance enabled him to travel and to become a munificent patron of Science. His most famous expedition was that with Captain Cook in the *Endeavour* when he took with him at his own expense Dr. Solander, the pupil of Linnaeus, two draughtsmen and two attendants. In 1778 he was elected P.R.S. and held the office till his death, exercising a generous but rather autocratic sway over the scientific world for whom his great collections were always open and his house in Soho Square a gathering point. He left his library and herbarium to Robert Brown, not only leaving him £200 a year but providing for the famous draughtsman Francis Bauer during his life that he might continue his drawings from new plants at Kew. As scientific adviser to George III he also arranged for collectors to gather plants for Kew from abroad.'

Apart from errors of statement there seems here a noticeable lack of enthusiasm. To mention these small and well earned bequests to his assistants and to make no mention of the founding of Australia is to show a strange want of proportion. No one would judge from the statement that his ample inheritance enabled him to travel, that it was Banks's example and influence which had throughout inspired and guided the outburst of successful exploration which marked the time and on which he had been the first to engage. The reader may be pardoned if, when he is told that Banks arranged for collectors to gather plants for Kew, he pictures him as busy not with the needs of explorers who took their lives in their hands but with routine measures for the transport of plants from what is here called, with some understatement, ' abroad.'

His successor in the Chair of the Royal Society, Sir Humphrey Davy, who never liked him, has left on record his unfavourable opinion of him, that ' he required to be regarded as a patron and readily swallowed gross flattery ' and that ' he made of his house a circle too like a court '. The surviving parts of his correspondence are sufficient again and again to refute the charges.

When in the early years of his presidency, in what he conceived to be the interests of the Royal Society, he forced the resignation of the Foreign Secretary, Dr. Hutton, there followed the famous ' Dissensions ', a revolt of a party headed by the eloquent Bishop Horsley. Banks in the end had his way and Hutton, it seems, a little later vented his spleen against Banks in a satirical skit which however he had the good sense not to publish. It was some years before Banks heard of its existence in a letter from an anonymous correspondent who had a manuscript copy of it in his possession. His reply† is not that of a man who readily swallows gross flattery ' As it is more than probable that (the writer) who does not want acuteness has, in placing Sir J. B.'s character in a ridiculous point of view, brought forward real faults in it, some of which he may not be sensible of ' he requests that it should be brought to his house.

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* *Life and Letters of Sir Joseph Hooker.*—L. Huxley, I, 10.

† Dawson Turner Copies, V, 193.

Among the manuscripts in the Royal Society is a slip of paper on which Banks has tolerantly set down* his own feelings under the assaults of the vituperative Bishop.

Jan. 8th 1784

> 'At 8 we met a full meeting. Each side took their station and looked as important as if matters of the utmost consequence to the State were the Subject of their deliberation. I felt at the moment like a bull going to be baited but I felt like a game bull who having been frequently brought out likes the Sport as well as the dogs and has more than equal chance of success.'

The Blagden correspondence sometimes shows him patient and forgiving when his friend was clearly in the wrong. Dr. Johnson approved of Blagden, Boswell tells us: 'Talking of Dr. Blagden's copiousness and precision of communication, Dr. Johnson said "Blagden, Sir, is a delightful fellow"'. Yet, somewhat unexpectedly, the letters do not always show him in a favourable light. Once Blagden quarrelled violently with his friend. He seems to have conceived that Banks with his great position was not sufficiently active in promoting his advancement. In a letter suddenly grown stiff and formal, Sir Charles Blagden presents his compliments to Sir Joseph Banks and goes on to deal with some trivial matter of routine as though to a complete stranger.

At the foot of this note Banks, greatly surprised and hurt, has added † 'This is the first time the Dr. ever addressed me thus and after an unbroken friendship of many years I think it most extraordinary'. And again a little later he writes to him, 'That a connection should have existed between us for near 20 years without my discovering till lately how far the motive to it on your side was an expectation of improving your fortune and advancing your situation in Society may appear to you extraordinary but it is nevertheless true.'

So far from requiring to be regarded as a patron, Banks here shows in a very different light; Blagden complaining that he has been too slow to exercise his patronage, and Banks oblivious that he has ever been regarded as a patron at all by the man whom he counted as his intimate friend. Banks used all his efforts to restore the friendship and in the end succeeded. The letters continue on the old familiar terms until the death of Blagden three months before that of Banks.

For some time Blagden was resident in Paris where he was much elated by the condescending attention paid to him by the young Bonaparte. He writes delightedly of Bonaparte and proudly conveys an invitation from the First Consul that Banks should visit him in Paris. He suggests to Banks ‡ that it would be well if King George could be persuaded to make Bonaparte a gift of a pair of the Kangaroos recently arrived from Australia. When apparently the King showed no desire thus to honour the upstart ruler of France, Blagden, determined to win favour with the First Consul, suggests § in the next place that the Royal Society should do itself honour by electing Bonaparte a Fellow 'in the most honourable way possible'. To this proposal I cannot find that Banks returned any answer.

If Banks was an autocrat, he was at any rate an autocrat who had never difficulty in accepting the advice of his subordinates and of reconsidering his own actions and conclusions in the light of their criticism. When the great French Botanist L'Héritier de Brutelle (1746–1800) visited London Banks was out of town but he was courteously received by his Librarian, Dryander, and by Blagden and given the run of the Herbarium. Soon, however, the faithful Dryander had to report that their guest was abusing the privileges granted to him. Dryander wrote that in seeking 'to determine the method of fructification' L'Héritier had forgotten what was due to his host and had gained his knowledge at the expense of the specimens. At once Banks wrote in violent remonstrance, so violent that Dryander and Blagden hesitated to deliver it to a person of such importance in the botanical world as L'Héritier. They consulted together and sent letters to Banks urging reconsideration and a milder protest. Dryander wrote :*

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* Misc. MSS. R.S. I, 30.
† Dawson Turner Copies, IV, 129.
‡ Dawson Turner Copies, XIII, 110.
§ Dawson Turner Copies, XIII, 130.

> 'We therefore perfectly agree with you of the necessity of keeping him at a good distance but submit to your reconsideration of it would not be breaking with him too much eclat to desire back the genera as he would not fail to make a great noise at Paris about his supposed ill treatment. . . We have agreed not to deliver your letter till we have received new orders from you.
>
> On Thursdays I cannot well prevent L'Héritier from being here in my absence but on other days in the week he shall not want my presence to keep him from abusing the liberty of the herbarium. The room upstairs I have locked and shall keep him clear of that.'

Blagden's letter is to the same effect but he adds that he has no doubt that he can quell the Frenchman if need arises. 'By the way, though pushing and forward enough, he has nothing of Faujas' audacious impudence and can be repressed by holding up a finger'. Banks took the advice of his assistants and rewrote his protest.

The whole incident is of interest because it shows Banks's character in a light which is not in keeping with the charges preferred against him by his opponents, and with the reputation which he has acquired in consequence. Although Banks is clearly very angry with L'Héritier, his subordinates have no hesitation in refusing to act upon his instructions and in urging reconsideration, advice which was accepted without protest. If Banks was overbearing and autocratic, as Bishop Horsley maintained, he is not so shown in his correspondence. The diffidence which made him rate his own contributions to science so lightly—a botaniser he calls himself, not a botanist—the shyness which went far to cut him off from ordinary social gatherings, the meekness which sent him pen in hand to set down on paper in what he called his 'Reveries' the case for and against himself in any dispute, the generosity and kindliness with which he strove at all times to help those who had won his regard, all this is revealed only by delving deep into his correspondence. Above all, Banks emerges as a man of close and enduring friendships, a thing least of all in accord with charges levelled against him by a disappointed and angry Bishop.

It looks as if, in course of time, Bishop Horsley has had his revenge. All that is remembered of Banks are the charges pressed home by the eloquent Bishop. Above the obliterating sand of the desert only his anathemas are exposed and the stature of a broken Colossus has been judged by a single surviving fragment.

The following paper was read in title,—

'Vegetative reproduction in *Encephalartos Ghellinckii* Lem.' By E. A. C. L. E. Schelpe.

VEGETATIVE REPRODUCTION IN *ENCEPHALARTOS GHELLINCKII* LEM.

By E. A. C. L. E. Schelpe.

Production of secondary apices has been recorded in *Encephalartos* and other cycads (Caldwell, 1907 ; Stopes, 1910 ; Chamberlain, 1919 *et al.*). The appearance of secondary apices or 'buds' may be induced by injury to the trunk or its apex. In *Encephalartos*, a new 'bud' may be formed in the cortex and continue growth if the apex of the trunk is removed (Chamberlain, 1919).

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* Dawson Turner Copies, V, 87.

In the course of a botanical survey in the Natal Drakensberg (South Africa) a number of specimens of *Encephalartos Ghellinckii* were removed from their natural habitat in the Tseketseke Valley at an altitude of 5100 ft. No specimens at higher altitudes were dug up and examined. This cycad is occasional in the Drakensberg on rocky grassed slopes and in scrub, marginal to forest, especially among groups of boulders at about 5000 ft. altitude. It also occurs on ledges on the Cave Sandstone cliffs and is locally frequent among ericoid scrub (Fynbos) at altitudes up to as much as 7200 ft.

At lower altitudes, the plants are frequently branched at about ground level into as many as seven trunks. This character was noted in *E. cycadifolius* by Pearson (1906). Relatively young plants have a single erect trunk with one or two very young stems arising from the base of the trunk. At a later stage, the older trunk overbalances and continues its growth in a procumbent position. The young stem or stems at the base of the old trunk then continue growth in an erect posture. This process may be repeated from time to time and ultimately give rise to the condition in relatively old plants, where there are a number of old procumbent trunks and one or two young erect trunks.

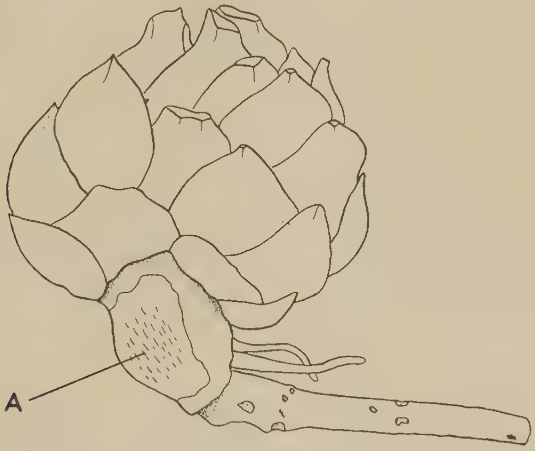

FIG. 1.—A root-produced tuber of *Encephalartos Ghellinckii* with the main root growing obliquely downwards and smaller lateral roots. The area of attachment to the parent root is shown at A. (½ Natural size.)

The figure should be inclined at an angle of 45° to the right to give the natural position of the tuber in the field.

In addition to this basal branching, new species may arise in the form of root-produced tubers (fig. 1). These are produced from well developed lateral roots at a depth of about a foot below the soil surface and from two to fifteen feet from the parent plant. Organic connection was traced by laying bare the root system of the plant. No tuber formation was observed on the main tap root. The tubers are sheathed in scales and show no signs of having borne fronds. Most of the tubers examined already had their own tap roots and a few small lateral roots as well. After removal from the parent plant, the larger tubers may develop fronds in cultivation.

The tubers cannot be confused with seedlings of this species. The seedlings possess a comparatively massive tap root and a stem far smaller than that observed in these root-tubers. Furthermore, the seedlings bear fronds at an early stage of development.

Although the production of secondary apices may be induced by injury, it is hardly probable that root-produced tubers are caused in this manner. It is reasonable to suppose that they constitute a normal, though possibly infrequent, method of vegetative reproduction.

SUMMARY.

Vegetative reproduction by root-produced tubers is recorded in *Encephalartos Ghellinckii* Lem. The habit and habitat of the species is described.

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PROCEEDINGS OF THE GENERAL MEETING ON 18 January 1951

Professor F. E. FRITSCH, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 4 January 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. I. Henry Burkill and Professor A. F. El-Helaly.

The President reported the deaths of William Williamson, Fellow of the Society, and Albert Harry Hamm, Associate *honoris causa.*

The following communications were read and discussed :—

Mr. J. G. VAUGHAN. An investigation in the stem apex of *Syringa vulgaris* L. with special reference to the formation of the leaf and leaf procambium. (Discussed by the President, Dr. B. Barnes, Mrs. C. M. Snow and Mr. Bryan S. Young ; Mr. Vaughan replied.) [To be printed in the Journal, Botany.]

Abstract,—

The anatomy of the stem apex of *Syringa vulgaris* L. has been investigated and zones have been determined (*a*) according to the direction of cell divisions and (*b*) according to the relative cell size and density of cell contents. The cells constituting the surface layer of the apex have been found to divide only by walls at right angles to the surface while the rest of the cells of the apex divide by walls in a variety of planes. Evidence is thus afforded for the well known tunica-corpus theory. On the basis of cell size and density of cell contents the stem apex shows a central zone and a flank meristem of smaller, more deeply staining cells. Leaf initiation appears to take place in the outermost two layers of the corpus. Special attention is paid to the development of the leaf procambium. It is found that procambium is produced by longitudinal divisions in the innermost layers of the corpus. Leaf primordia of extremely early age have been examined and, in all cases, procambium is found in close attendance and is continuous with the procambial network of the bud. No evidence can be found to support the older idea of procambium making its appearance in the base of a leaf primordium and then developing acropetally into the growing leaf and basipetally into the axis of the bud to join the procambial network.

Discussion,—

In congratulating Mr. Vaughan on his clear account the President said he had been particularly interested in his description of the formation of the procambium in the leaf primordium. He would like to ask Mr. Vaughan about the first origin of this procambium. Did it start differentiating from the procambium of the stem upwards into the primordium or what was its exact origin ?

Mrs. C. M. Snow asked for how long the apical meristem of a young leaf continued to be active.

Mr. Bryan S. Young asked if Mr. Vaughan had found any evidence for the existence of the Prodesmogen ring mentioned by Lewis in his work on *Syringa*.

In reply, Mr. Vaughan said that he had found no such evidence of the Prodesmogen ring ; but was unable to answer Mrs. Snow's question.

Dr. T. E. T. Bond. Applicability of the Logarithmic series to the distribution of the British *Hieracia* and other plants. (Discussed by Dr. C. B. Williams and Mr. J. G. Skellam ; Dr. Bond replied.)

APPLICABILITY OF THE LOGARITHMIC SERIES TO THE DISTRIBUTION OF THE BRITISH *HIERACIA* AND OTHER PLANTS

By T. E. T. Bond, D.Sc., F.L.S., University of Bristol.

The logarithmic series of Fisher *et al.* (1943), recently brought to the notice of this Society by Williams (1947 *a*), concerns the subdivision of a population into groups. Thus, in random samples of a mixed population, the numbers of groups represented by one, two, three or more individuals respectively may be expected to approximate to the terms of the series

$$n_1 \quad : \quad \frac{n_1 x}{2} \quad : \quad \frac{n_1 x^2}{3} \quad : \quad \frac{n_1 x^3}{4} \ldots .$$

where n_1 is the number of groups of one individual only, and x is a constant (for the sample) of less than unity. The series has two main applications in biology :—

(1) It expresses Willis' (1922) 'hollow curve' of distribution (of individuals classified into species, species into genera, etc.)—originally conceived in terms of the hyperbola—in the form of a convergent series which can be summed to a finite value corresponding to the number of groups in any given sample.

(2) For samples of different sizes, from the same population, x increases in proportion with n_1. The ratio $\frac{n_1}{x}$ is therefore characteristic of the population as a whole and it is described as the constant 'α', the Index of Diversity. It follows from the properties of the series that, for samples of reasonable size, the index of diversity is a measure of the proportional relationship that exists between the number of species in a sample and the logarithm of the number of individuals it comprises (or, for most plant communities, of the area it occupies).

Williams (1944, 1947 *b*) has given numerous examples of the use of the logarithmic series in which, however, the problems of geographical distribution of British plants, as apart from those of their ecology, are scarcely represented. The large body of distributional data to be found in Pugsley's (1948) work on the British *Hieracia* provided an opportunity for making good this deficiency by a further test of the usefulness of the proposition. Both applications mentioned above have been tried out on this material, and they are dealt with below in that order.

FREQUENCY DISTRIBUTION BY VICE-COUNTIES.

The Table on pp. 336–40 of Pugsley's (1948) paper gives the distribution of the 248 British species of *Eu-Hieracium* in terms of the numbers * of vice-counties that they inhabit in the several regions of the country. Re-arranging

TABLE I.

Vice-comital Frequencies of British *Eu-Hieracia*.
(Data from Pugsley, 1948).

Frequency (v.c.'s)	“Britain”		“North Britain”	“Wales”	“Ireland”
	All spp.	Endemics			
1	85	69	85	42	17
2	33	27	18	17	12
3	21	18	14	12	6
4	9	4	9	10	4
5	17	10	11	3	6
6	17	14	13	4	—
7	8	6	8	—	—
8	4	4	4	—	—
9	7	3	5	2	—
10	5	5	8	3	—
11	8	6	2		1
12	2	—	1		1
13	2	1	2		—
14	4	2	—		—
15	1	1	—		—
16	—	—	3		1
17	2	2	1		
18	3	—	—		
19	—	—	—		
20	2	1	—		
21	2	2	1		
22	1	—			
23	2	1			
24	—	—			
25	—	—			
26	1	—			
27	3	1			
—	—	—			
33	1	—			
—	—	—			
38	1	—			
39	1	1			
40	1	1			
—	—				
42	1				
48	—				
—	2				
—	—				
54	1				
—	—				
79	1				
S :—	248	179	185	93	
N :—	1613	825	691	239	
N/S :—	6·5	4·6	3·7	2·6	
α :—	81·8	70·4	82·8	56·0	
S.E. :—	3·4	4·0	5·0	5·8	
% :—	(4·2)	(5·6)	(6·0)	(10·4)	

The values at the base of the columns are as follows :—

S— Total species.
N— Total (species × frequencies).

α—The Index of Diversity, with its standard error, and the latter expressed also as a percentage.

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* Certain small discrepancies were noted between the totals for various categories as derived from the Table and as referred to earlier in the Discussion (*loc. cit.* pp. 329–35). All figures quoted here are from the Table.

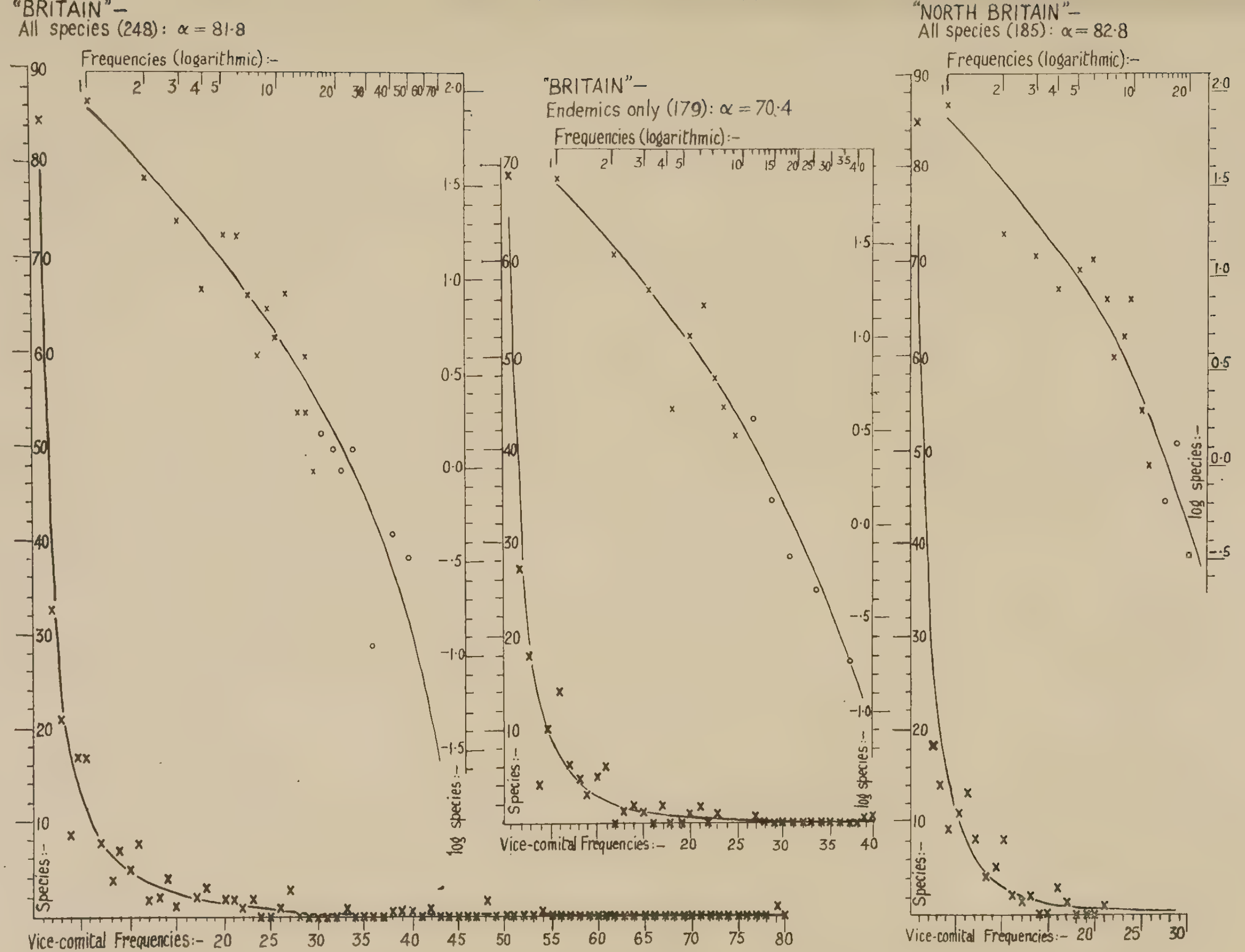

FIG. 1.—Vice-comital frequencies of British *Eu-Hieracia*—'hollow curves' and logarithmic plotting following Williams (1947 *b*). Both here and in fig. 3, zero values have been eliminated from the logarithmic plotting by taking averages. The averaged data are represented by the small circles. (Data from Table I.)

these data as in Table I below, it will be seen that no fewer than 85 species are confined in their distribution to a single vice-county; whereas only 25 species, or say 10 per cent. of the whole, inhabit 17 or more vice-counties, and none is known from more than 79 vice-counties in all. Particular interest attaches to the 179 endemics, and to Pugsley's 'North British' area (North Scotland, South Scotland, and North England together); and, for both of these categories, the distribution is again of the same type. In fact, as fig. 1 shows, a series of quite good 'hollow curves' is obtained from these data. The curves were fitted by the method of Williams (1947 *b*), using the constants given in the Table; the degree of similarity in their index of diversity values will be noted.

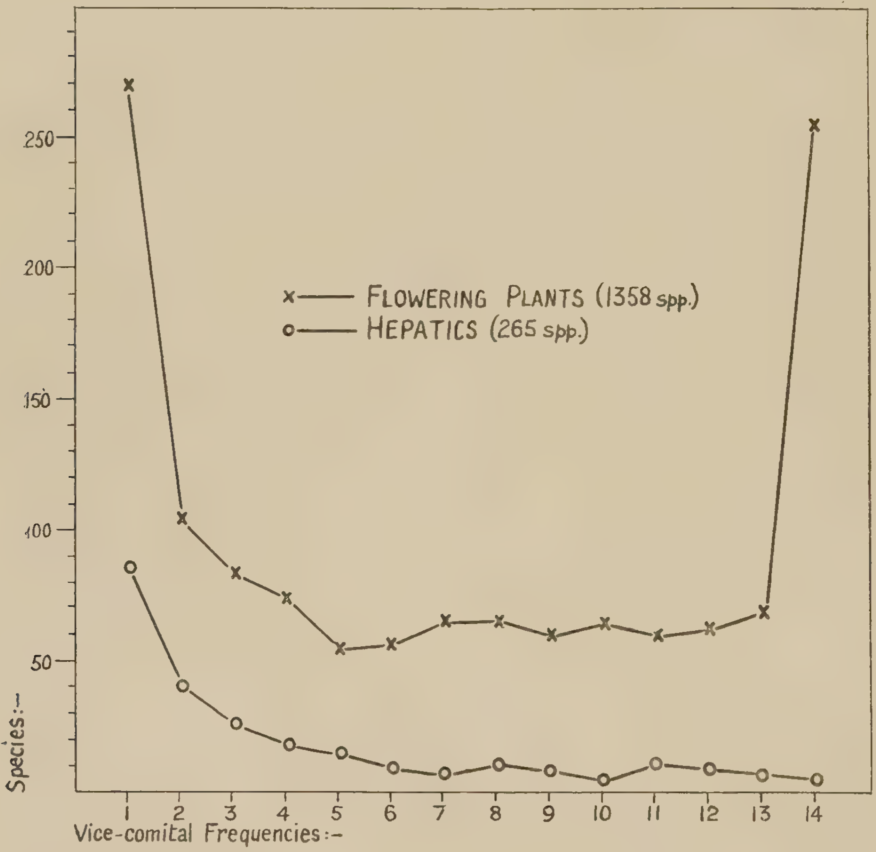

FIG. 2.—Vice-comital frequencies (vice-counties by eights) of British flowering plants and hepatics.

The *Hieracium* flora of Britain is, of course, a very specialized element, of which the classification has been carried much further than for the majority of plants. By way of comparison, a similar tabulation was carried out for the Angiosperm species in the *London Catalogue*, 11th edn. (excluding *Rubus*, *Rosa*, *Hieracium*, *Euphrasia* and *Carex* spp., and species doubtfully native, etc.), and for the Hepatics listed by Wilson (1930). Amongst the former, as is well known, there are more than a hundred species which occur in every vice-county

TABLE II.

Vice-comital Frequencies of Floristic Elements of the British Flora. (Data from Matthews, 1937.)

Frequency v.c.'s.	Elements											*
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
1–10	17	26	20	2	30	25	12	10	20	31	7	8
11–20	4	10	9	3	14	10	15	4	5	21	1	3
21–30	4	10	8	2	14	7	4	2	3	12	—	2
31–40	1	5	5	—	9	2	10	3	1	6	—	1
41–50	2	5	6	2	17	9	8	—	1	2	—	1
51–60	—	5	1	2	8	5	6	1	—	—	1	3
61–70	1	6	5	4	13	6	7	4	—	1	—	5
71–80	—	4	2	3	7	6	2	—	—	1	—	1
81–90	—	—	2	2	4	6	8	1	—	—	—	3
91–100	—	—	3	2	5	3	10	—	—	1	—	3
101–110	—	1	5	—	3	2	6	—	—	—	—	3
111	—	—	1	—	—	—	2	—	—	—	—	1
112	—	—	1	—	—	1	1	—	—	—	—	6
Total species :	29	72	68	22	124	82	91	25	30	75	9	40

* This column refers to a sample of 40 species drawn at random (but excluding ' micro-species ') from the *London catalogue*, 11th edition.

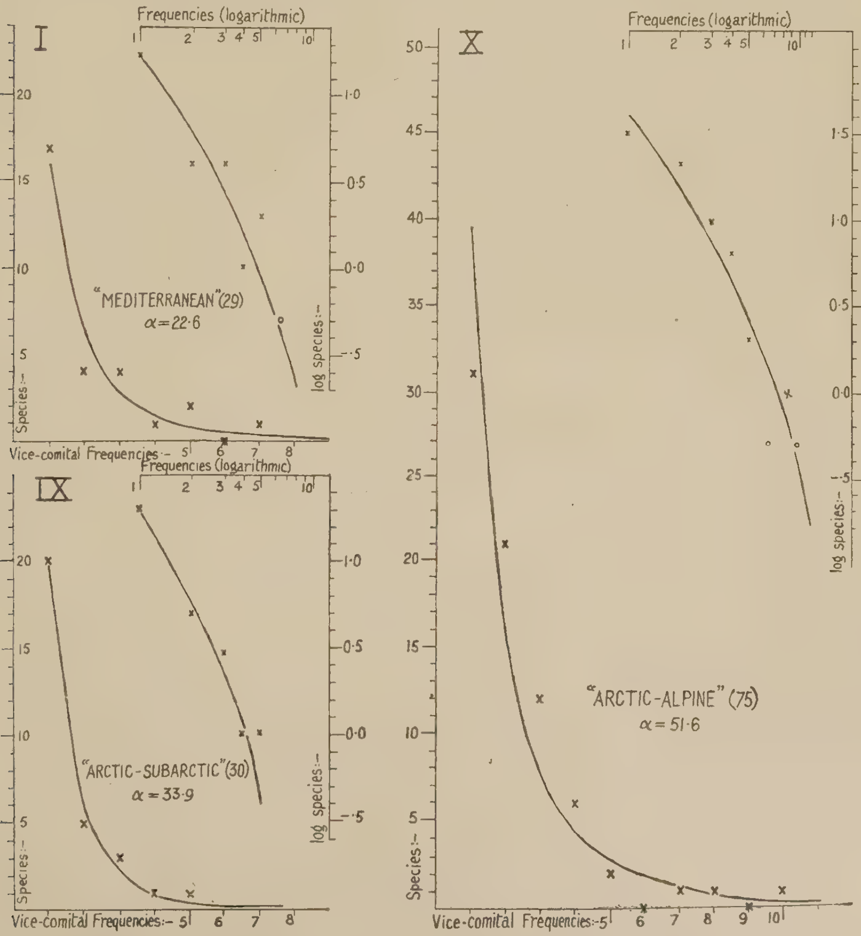

FIG. 3.—Vice-comital frequencies of certain floristic elements of the British flora, as recognized by Matthews (1937). (Data from Table II.)

in the country ; this applies only to some half dozen of the latter. Grouping the vice-counties by eights, as in fig. 2, helps to ' smooth out ' the distributions which, however, even with the omission of the most abundant species (inhabiting 105–112 vice-counties), bear only the slightest resemblance to the logarithmic series. Nevertheless, in the Angiosperms, at least, the preponderance of rarer species was sufficiently noticeable to warrant further investigation. This was done with reference to Matthews' (1937) subdivision of our flora—again, excluding micro-species of the more ' critical ' genera—into floristic elements based on their geographical range outside the British Isles. All eleven elements considered in detail by Matthews were tabulated, together with a sample of forty species drawn at random from the previous ' London Catalogue ' selection. This time, grouping the vice-counties by tens (Table II), some quite good logarithmic distributions were obtained ; particularly, as in fig. 3, for the Mediterranean (I), Arctic-Subarctic (IX) and Arctic-Alpine (X) elements.

The Species/Log Area Relationship.

Again re-assembling Pugsley's (1948) data*, as in Table III, a comparison can be made between the areas of the several regions of the country and the numbers of *Hieracium* spp. (total, and endemic to Britain) that they support. Fig. 4 shows the special significance of the three regions of ' North Britain ' : in both instances they give a reasonably close fit to a straight line regression for species (y) on log area (x) which, by extrapolation, also approximates to the values for ' North Britain ' as a whole and for the entire country. Thus, for the northern half of the country, at least, the logarithmic distribution appears to hold good ; whilst the exceptions afforded by the relative richness of the *Hieracium* flora in Wales and its paucity in the southern half of the country and in Ireland are entirely in accordance with the geographical facts of the situation as revealed in Pugsley's discussion. Williams (1944, 1947 *b*), however, shows that in a population distributed according to the logarithmic series, the proportional species/log area relationship is approximate only and that, in any case, to establish the applicability of the series to any given instance, the actual number of individuals must be taken into account. Using the values of α corresponding to the calculated (linear) regression coefficients, and plotting the theoretical regressions from the formula

$$S=\alpha\log_e(1+N/\alpha)$$

(Where S is the expected number of species corresponding to a population of N individuals), one finds that the species log *population* relationships are now, in fact, appreciably non-linear towards the base, and, moreover, that the calculated populations are exceedingly small for the areas involved. The point is illustrated by fig. 4, where the relative positions of the logarithmic (dotted) regressions for *population* and the previously noted linear regressions for *area* have been determined with reference to the species of the ' North British ' region. Thus, for the total flora (left-hand diagram) of $S=185$ species, with $\alpha=85{\cdot}0$, the value of N works out at some 660 individuals only, or about one individual in 67 square miles : similarly, for the endemic species (right-hand diagram), the value of N works out at 420, or about one individual in 106 square miles.

Population densities of this order, as demanded by the logarithmic series, would appear to be absurd. Nevertheless, the evidence for a consistent species/log area relationship in the N. British *Hieracium* flora is too strong to be ignored ; and a recent paper by Archibald (1949) suggests an alternative interpretation of it. Archibald points out that plant communities in general are of finite size and comprise a finite number of species. Accepting the fact that increasing area is best represented on the logarithmic scale, she concludes that the species/log area curve is in fact sigmoid : she notes, moreover, that over the central

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* See footnote, p. 30.

TABLE III.

Regional Distribution of British *Eu-Hieracia*.
(Data from Pugsley, 1948, etc.).

Regions, and abbreviation			Area, sq. m.	Log area	Species	
					Total	Endemics
1	N. Scotland	NS	22,340	4·3491	138	93
2	S. Scotland	SS	7,440	3·8716	41	24
3	N. England	NE	14,960	4·1750	82	45
4	Midlands	ME	20,660	4·3152	41	18
5	S. England	SE	13,840	4·1412	33	16
6	Wales	W	8,010	3·9036	93	63
7	Ireland	IR	32,410	4·5106	48	32
8	N. Britain (1, 2, 3)	NB	44,740	4·6507	185	124
9	Do., with Midlands (1, 2, 3, 4)		65,400	4·8156	198	134
10	Do., do., with Wales (1, 2, 3, 4, 6)		73,410	4·8658	233	166
11	Whole country (1, 2, 3, 4, 5, 6, 7)	T	119,660	5·0780	248	179

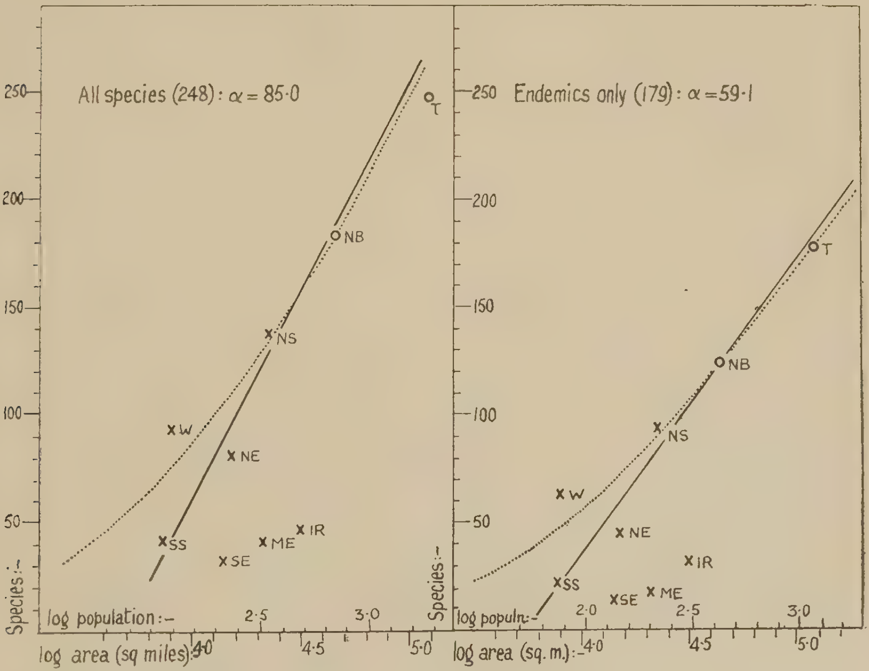

FIG. 4.—Species/area (solid) and theoretical species/population (dotted) regressions for British *Eu-Hieracia*. Crosses, ×, refer to regions listed separately by Pugsley (1948), circles to aggregates. (Abbreviations as in Table III). The graphs are computed from the values for the three component regions of 'North Britain' only.

portion of such a curve the relationship is approximately linear. Archibald's expression for the sigmoid curve is in the familiar form of Robertson's equation for an autocatalytic reaction

$$\frac{dy}{dx} = k'y\,(K-y),$$

which, for purposes of computation, is integrated to give

$$\log \frac{y}{K-y} = k\,(\log x - \log x_{50}),$$

x_{50} being the estimated area inhabited by *half* the observed total of species

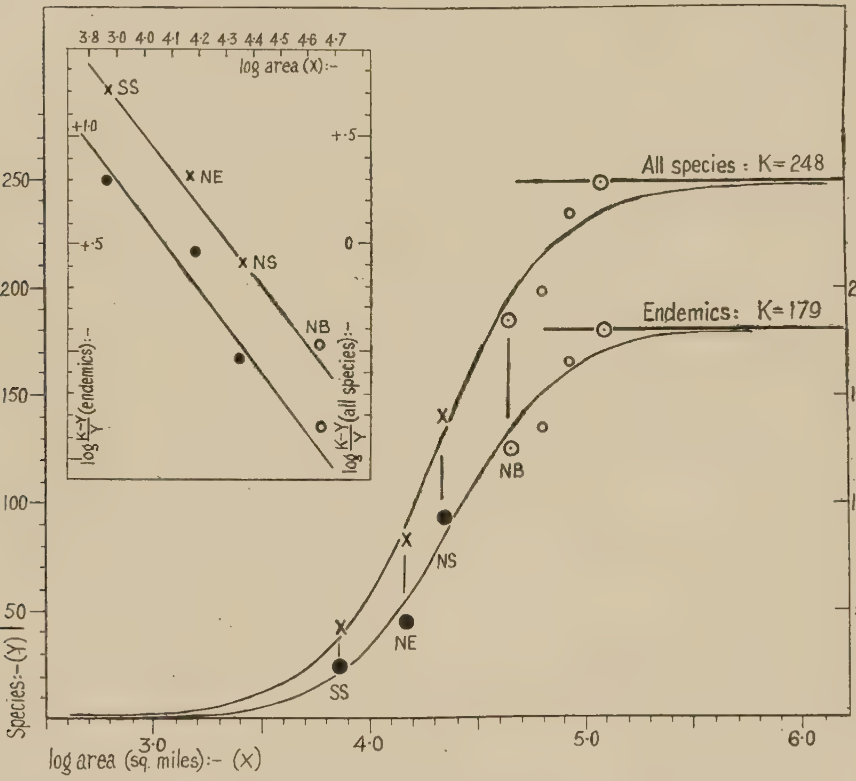

FIG. 5.—Logistic plotting of species/area relationships in the North British *Eu-Hieracia* $\left(\log \frac{K-y}{y}\right.$ regressions inset$\left.\right)$. The graphs are computed from the values represented by the crosses, ×, and solid circles, ●, only. Large circles, O, refer to 'North Britain' as a whole and to the entire country; small circles to the areas resulting from the successive addition to 'North Britain' of the 'Midlands' and of 'Wales'. (Data in Table III, and compare fig. 4).

$(y=\frac{1}{2}K)$. The writer has previously (Bond, 1945) given reasons for preferring the Verhulst–Pearl logistic formula

$$y = \frac{K}{1 + Ce^{-rt}}$$

for the sigmoid growth curve, whereby the x_{50} estimation is obviated, and the curve can be fitted from the value of the upper asymptote K (known in this instance), and from the 'growth constant' r which is determined by the linear regression of log $\frac{K-y}{y}$ upon x. This formula has been applied to the ' North British ' data, with the results shown in fig. 5. Based only on the values for the three regions separately, the curves pass close to the values for ' North Britain ' as a whole and to those resulting from the successive addition to that area of the ' Midlands ' and of ' Wales '. The essential similarity between the ' total ' and the ' endemic ' floras is at once revealed by the log $\frac{K-y}{y}$ regressions, which are virtually identical ; a further advantage of the logistic calculation being thereby demonstrated. It should be noted that the relationships expressed by the sigmoid curves are for *areas* and species only, i.e. without implications of population density except possibly for the limiting areas where $y=1$ species, namely, about 720 square miles for all species and 1120 miles for the endemics. The significance of these values is not clear ; and, since they occur in the extreme ' tail ' of the curves, they are in any case highly subject to error.

Discussion.

The practical value of the logarithmic series in the computation of ' hollow curves ' has been amply demonstrated by Williams (1947 *b*) and other authors, and there is no need to stress this aspect of its present application. The interest lies rather in the use of vice-comital frequencies as the distributional data ; and in the contrast that is revealed between those groups, namely, the *Hieracium* populations and certain of Matthews' (1937) elements of our flora, for which the ' hollow curves ' are appropriate, and those others, namely, the flowering plants as a whole (or a random selection from them) and the liverworts, for which they are obviously not so. Vice-comital frequencies are necessarily employed without reference to the numerical abundance of the species concerned. Thus, a ' rare ' species, inhabiting one or two vice-counties only, will sometimes, in those areas, greatly exceed in abundance a species of wide distribution elsewhere. An attempt to correct the data for discrepancies of this sort would appear to be subject to grave errors : for the purposes of the logarithmic series, the ' individual ' must here be reckoned as a collective entity comprising the whole population of a species within the 800-odd square miles corresponding to the average vice-county area. The value of the concept lies in the significance of the populations to which the ' hollow curves ' best apply, namely, the *Hieracium* flora considered as the result of close analysis at, essentially, the sub-specific level, and the others as assemblages of (macro-) species selected on the basis of their common geographical relationships. Our flora as a whole, without further analysis or selection, is perhaps too imperfectly recorded and too heterogeneous in composition to afford the data for which the logarithmic series is appropriate.

The further implication of the logarithmic series, namely, the existence of a proportional relationship between the number of species in a population and the logarithm of the number of individuals it comprises, is only in part sustained by the present data. The population densities calculated in accordance with the logarithmic interpretation again raise the question whether the series is applicable to aggregate individuals—apparently, this time, of about one-tenth the size of the vice-county populations which were the basis of calculation for the ' hollow curves '. The similarity in the values for the index of diversity as obtained by the two methods of computation should be noted. No such difficulty arises if the results are interpreted in terms of Archibald's (1949) suggestion that the species/log *area* relationship alone need be considered, and that the best representation of it is in the form of a sigmoid curve (which is approximately linear in its central portion). The mathematical consequences of this relationship, particularly with regard to its effect on the ‘hollow curves’, would repay further investigation.

I am indebted to Miss Sheila E. Beckett for her assistance with the calculations and the preparation of the Figures.

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ADDENDUM.

A further (1950) paper by Dr. C. B. Williams, *The application of the logarithmic series to the frequency of occurrence of plant species in quadrats* (J. Ecol. **38**, 107–38)—suggests an alternative analysis of the vice-comital frequencies discussed in the first part of this communication, for which purpose the several vice-counties might be regarded as so many large-sized quadrats. The calculations involved, however, would appear to be excessively laborious.

Discussion,—

Dr. C. B. WILLIAMS said that the results obtained by Dr. Bond were interesting as showing still another biological application of the logarithmic series. If area covered could be taken as proportional to the number of individuals present then the relation between the number of species and the number of vice-counties per species was in general similar to previous results on abundance.

The relation discussed however by Dr. Bond on the number of species found in larger and smaller areas, consisting of different numbers of vice-counties, resembled more closely the relations that the speaker had recently discussed in the *Journal of Ecology* between numbers of quadrats and numbers of species. The vice-counties could be roughly looked on as very large quadrats. In these relationships either J-shaped curves—reversed J curves (*b*) or U-shaped curves can be obtained according to the size and number of quadrats taken. Thus the U-shaped curve found by Dr. Bond was not out of keeping with previous results.

PROCEEDINGS OF THE GENERAL MEETING ON 8 February 1951

Professor F. E. Fritsch, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 18 January 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. P. Greig-Smith, Professor James Small, Dr. C. H. Spiers, Dr. C. G. G. J. van Steenis, Mr. John W. Walton, the late Mr. William Williamson, the Fouad I University, Abbassia, Cairo, and Messrs. Methuen & Co., Ltd.

Special reference was made to the donation from Dr. C. H. Spiers,—a MS. by William Markwick, F.L.S., dated 1796 : ‘ Extracts from and remarks on several passages of the Count de Buffon's Natural History of Birds ’.

The President reported the death of Professor Lucien Cuénot, Foreign Member of the Society.

Dr. J. W. Jones showed a film entitled ‘ The Spawning Behaviour of the Salmon ’. (Discussed by Dr. E. Trewavas, Dr. P. C. Esdaile, Mr. R. R. Broome, and Mr. A. G. Leutscher ; Dr. Jones replied.)

Abstract,—

The film was introduced by a brief résumé of the life history of the salmon and of the various theories relating to the spawning behaviour of salmon. Research results on the sexual maturity of the salmon parr, and the results of some experiments with the sperm of salmon parr, were discussed. A description of the tank was given, and some aspects of the spawning as shown in the most recent film were dealt with before the film was shown.

Dr. A. Tindell Hopwood, Zoological Secretary, made some remarks on the Society's Collections and Archives, and the publications connected with them.

PROCEEDINGS OF THE GENERAL MEETING ON 22 February 1951

Professor F. E. Fritsch, F.R.S., President,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 8 February 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting :—Mr. H. A. Hyde, the National Institute of Oceanography, London, the Royal University, Uppsala, and Messrs. Constable & Co. Ltd.

The President reported the death of Dr. Robert Brooks Popham, Fellow of the Society.

The following proposed Alterations in the Bye-Laws were read for the first time :—

Chap. 1, *Sect.* 10. Section to read as follows :—

No person elected a Fellow of the Society shall be entitled to exercise any privilege as such, nor shall he be admitted nor his name entered in the List of the Society until he shall have paid his Admission Fee if any and the Contribution for the current year ; and unless he pay his Admission Fee if any and the

Contribution for the current year within two calendar months or within such further time as the Council may grant, the election of such Fellow shall be void; and no such person shall have liberty to vote at any Election or Meeting of the Society before he shall have been admitted as directed in the preceding Section.

Chap. 2, *Sect* 3. Section to be deleted.

Chap. 2, *Sect* 4. To be re-numbered Section 3 and to read as follows :—

In the month of November in each year the Council shall cause to be suspended in the Library of the Society a List of the Fellows whose Annual Contributions are due and owing, and notice thereof shall forthwith be forwarded to every Fellow whose name appears in such List. If the Contributions due from any Fellow named in the said List shall not have been paid within three months after the first suspension of the List the Council may remove such Fellow from the Society. The Contributions due from any Fellow may be remitted in whole or in part by the Council.

Add a new Sect. 4.

A Fellow shall be deemed to belong to the Society until he has either signified in writing his wish to withdraw from Fellowship or has ceased to be a Fellow under Bye-Laws, Chapter 2, Section 3, or Chapter 7.

Chap. 6, *Sect*. 2. Section to be deleted.

A JOINT DISCUSSION WITH THE SYSTEMATICS ASSOCIATION: 'Taxonomic treatment of Biological Races', was held, which was opened by Mr. B. L. BURTT, Dr. C. A. HOARE, F.R.S., Dr. R. W. G. DENNIS and Mr. P. F. MATTINGLY.

A general discussion followed, in which the following took part :—the President, Mr. Sylvester Bradley, Dr. R. Melville, Prof. T. G. Tutin, Dr. O. W. Richards. Mr. Burtt, Dr. Hoare, Dr. Dennis and Mr. Mattingly replied.

The following paper was read in title :—

'The life-history of the multiform species *Jassa falcata* (Montagu) (Crustacea Amphipoda) with a review of the species'. By E. W. SEXTON, F.L.S., and D. M. REID, F.L.S. [Printed in the Journal, Zoology, **283**].

JOINT DISCUSSION WITH THE SYSTEMATICS ASSOCIATION : TAXONOMIC TREATMENT OF BIOLOGICAL RACES

THE TAXONOMIC TREATMENT OF BIOLOGICAL RACES IN FLOWERING PLANTS

By B. L. BURTT.

In the flowering plants there are very few biological races that have been studied thoroughly enough to allow any critical discussion of their taxonomic treatment. On the other hand there is a mass of un-coördinated, but vaguely relevant, data. Variation is known in a wide range of biological characters. Every new selective weed-killer brings with it the taxonomic risk that sensitive and resistant strains of species will be discovered; just as streptomycin and penicillin have been followed by the discovery of strains of pathogenic organisms differing in their reactions to these drugs.

Our title this evening compels me to marshal the data according to its taxonomic value rather than its biological nature. Rather reluctantly, therefore, I have abandoned any attempt to show the range of characters that may be involved. Instead I have restricted my remarks to two kinds of variation : that concerning general growth processes (especially in relation to climate) and that concerning the production of essential oils. I shall, I hope, have time to conclude with a few words about races of parasitic plants.

Diagram showing types of biological variation arranged according to an artificial key.

- Physiological differences within populations :
  - *E.g. Phenology of leaf-unfolding in* Fagus.
  - *Variation of oil-types in* Eucalyptus.
- Physiological differences between populations :
  - Morphological differences absent or vague :
    - Populations sympatric :
      - *E.g. Variations in vigour of growth in* Lemna *and* Scilla.
      - *Variation of oil-type in* Cymbopogon martini.
    - Populations allopatric :
      - *E.g. Climatic variants : frost-hardiness in* Pinus.
      - *Climatic variants : photoperiod-response in* Phleum.
  - Morphological differences slight but definite :
    - *E.g. Different oil-types :* Origanum dubium *and* O. majoranoides.

I shall classify my examples in a taxonomic key, but this is to be regarded as no more than a mental convenience (see diagram).

No sexually reproducing population is homogeneous, either morphologically or physiologically. Hence it is convenient to distinguish in the first place *physiological differences within populations*. Individual trees in a wood will often come into leaf in a definite order, some early, some late. In the beech, at least, this variation has been shown to have a genetic basis (Raunkiaer, 1919).

Only rarely does the need arise for a system of reference to distinguish such variants within a population. It has done so in the Australian oil-producing eucalypts. In otherwise homogeneous stands of *Eucalyptus australiana* and other species it has been found that a few variants may occur producing oil of a different composition : an oil which may be regarded commercially as an unacceptable adulterant of the normal type. The terms variety A, B, C, etc. of the species concerned have been used for these forms. Quite rightly no nomenclature within the orthodox taxonomic system has been attempted (Penfold & Morrison, 1935).

Sporadic variants of this type do not constitute biological races. By artificial selection they may give rise to strains of economic importance which become widespread. These, fortunately, will be subject to agronomic rather than taxonomic classification.

Natural selection, especially when the species is near its limit, will tend to make each population more homogeneous. But the populations themselves may diverge. The remainder of my remarks are concerned with *physiological differences between populations.*

The next key character requires some explanation. We are meant to be discussing races which are not differentiated by morphological features, yet my character is *Morphological differences absent or vague.* That is because I believe that to get the proper picture for the flowering plants we must be prepared to consider any group whose recognition has been primarily due to biological features. At the end of this key we shall come to a group where morphological distinctions, though slight, are definitely present. I must also explain what I mean by vague morphological characters. It is a fact that, as far as I can trace, practically no effort has been made to apply refined morphological techniques, such as careful analysis of shapes and the statistical examination of the results (cf. Woodson, 1947), to problems of physiological races.

The next character depends on whether the populations, between which there are physiological differences, occur in the same general area (*sympatric*) or are geographically isolated (*allopatric*).

In the sympatric group reference may be made to the discovery by Blackman and Rutter that five stocks of the bluebell (*Scilla non-scripta*) from different localities in southern England were all physiologically distinguishable when grown under uniform conditions (Blackman & Rutter, 1950). Dr. Ashby has kindly informed me of unpublished work by Miss Wangermann which shows that stocks of *Lemna minor*, from Manchester and Oxford respectively, differ in length of life of frond and rate of production of daughter fronds (Ashby, 1951). This is particularly interesting because *Lemna* has such a simple plant-body that in no other genus of the flowering plants are physiological races, indistinguishable by morphological features, more likely to be found. Races distinguished only by features of growth, such as these in *Scilla* and *Lemna*, may well prove to be the rule rather than the exception in flowering plants.

Now we come back to oil-production again: this time in an Indian grass, *Cymbopogon martini*. Two races are known and were investigated by Mr. Burkill as long ago as 1909. One, called *motia*, is the source of a palmarosa oil. The other, *sofia*, yields a ginger-grass oil. The natives are able to recognize these two variants by their general appearance, although they will use their sense of smell as a final test. But the recognition-characters used are not the same from place to place. In one area *sofia* has radical leaves and is bunched and shorter than *motia*; in another it is recognized by its broader leaves, darker colour, large spikes and taller growth. Mr. Burkill makes it clear that there are ecological differences between the two forms and either may be the taller, according to which is most favoured by a particular habitat or local climate. Thus the recognition-characters of the natives might be useless, in this case, for more critical study, but Mr. Burkill suggested as a distinguishing feature the angle at which the leaves depart from the culm: this still needs to be more thoroughly studied. The two variants are formally classified as varieties (Burkill, 1910).

Turning from sympatric to allopatric populations, there is a vast amount of work on physiological differences connected with climate. It is a subject of the greatest importance in forestry and for the uninitiated I would mention that though there is much information published under the heading ‘ climatic races ’, there is also a great deal under the phrase ‘ seed proveniences ’. There is a most valuable annotated bibliography up to the year 1933 in the Indian Forest Records (Champion, 1933). Other important papers are those by Langlet (1936) and Kalela (1937). I can only touch the fringe of an enormous subject.

I select the common pine (*Pinus sylvestris*). Dallimore and Jackson (1948, pp. 556–557) say ‘ The following geographical varieties have been described, but do not appear to be as well marked in character as their descriptions would indicate. . . they are practically indeterminable from hand specimens ’. But foresters know well that seed from different wild localities will give them stands differing in rate of growth, shape of crown, hardiness, length of growing season, resistance to disease, and so on (Münch, 1937). I have little doubt in my own mind that these vague geographical varieties, with which the taxonomist has so unwisely encumbered himself, were originally described just because of these more obvious differences in vigour, etc. Recent work on frost-resistance in *Pinus* is most interesting, because this is one of the rare instances in which the fundamental physiological side has not been neglected. It is established (Langlet, 1936) that as winter approaches the water-content diminishes and starch and acidity, and sometimes chlorophyll, decrease; on the other hand, sugars, fats, reserve cellulose, tannin and catalase increase. These changes represent the transition to a period of winter rest. In the more northerly races the content of these substances is higher and the frost resistance greater.

American work with *Phleum pratense* (Evans & Allard, 1934) showed that sixteen strains of this species all reacted differently to a series of experiments in which the daily photoperiod was controlled. This, of course, is only another aspect of much of Turesson's work. To take just one simple example, he found that primrose (*Primula acaulis*) from Trieste, when grown in Sweden was in ripe fruit when a Scottish plant grown alongside was only in flower: and the leaves of the Trieste plant were twice the size of the others.

The implication of this work on *Pinus* and *Phleum* is that, while each local race may be particularly well adapted to its local climate, the variation must be regarded as continuous. There are no sharply defined geographical or climatic subspecies, but the whole range of variation, of which the individual stages are usually called ecotypes, forms a cline.

Lastly we come to the character which contrasts with *Morphological differences absent or vague,* namely *Morphological differences slight but definite.* My example refers to the species of *Origanum* from Cyprus. One (*O. dubium* Boiss.) yields origanum oil, the other (*O. majoranoides* Willd.) marjoram oil. The peasants do not confuse them and both are exploited. The leaf-differences are certainly somewhat vague and require further analysis, and I can find no floral characters; but the shapes of the inflorescences are markedly different and I agree with Stapf's judgment that they are best classified as distinct species (Stapf, 1913). It will be noted that they are sympatric, but intermediates have not so far been discovered.

I will only say a few words about biological races in parasitic plants. There are three well known races of mistletoe (*Viscum album*): one is parasitic on a widish range of broad-leaved trees, another is restricted to fir, and a third to pine (von Tubeuf, 1923). There appear to be morphological differences between these so-called varieties (size and shape of leaves, colour of berries, etc.) and one is left with the impression that if they were subject to a more critical study the physiological characters might well be found to be linked to recognizable morphological features and that the races could rank at least as subspecies. *Viscum,* incidentally differs from all the other examples of biological variants so far mentioned in that the whole population of *V. album* can be assigned to one or other of these races by field observation alone; the impossibility of transfer from one group of hosts to another, however, has only been tested in one or two selected examples. Further work to establish the constancy of this feature is desirable.

Orobanche minor, grows on a very wide range of host plants and, so far as is known, seed from any form of the species can be raised on *Pelargonium zonale. O. hederae* differs slightly in floral characters, is only found on ivy and will not grow on *Pelargonium.* These plants are being studied by Dr. Greenwood at Leeds and he has kindly given me much unpublished data. Seed-germination will only take place in the presence of an appropriate root exudate. For *O. minor* effective exudates are given off not only by its normal hosts but by many other plants as well. For *O. hederae* however, the only effective exudate so far discovered is that from ivy roots (Greenwood, 1951). This research seems to be getting down to a basic physiological cause of the species-difference which in taxonomic works rests on rather uncertain morphological characters and on observation of the hosts.

In conclusion I would emphasize three points:—

1. The need for really critical morphological study whenever biological races are encountered. The geneticist has progressed from the study of simple

genes to the more complicated patterns of polygenic inheritance. The taxonomist, if he is to tackle these problems at all, must not only be prepared to make more use of simple statistics, he must make a far greater effort in his morphological analysis to produce data which are suitable for such treatment.

2. Physiological characters can still only be assessed, with rare exceptions, by their outward expression. We must hope that progress will be made with their interpretation in terms of fundamental physiology. But we lack any body of data on the comparative physiology of related species and thus have as yet no background against which to assess differences between biological races.

3. Nearly all the available information has accrued as a result of work with a strong economic bias. Fundamental research specifically planned to lay bare and illuminate the general problems is badly needed.

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THE TAXONOMIC STATUS OF BIOLOGICAL RACES IN PARASITIC PROTOZOA

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In a previous paper (Hoare, 1943) I gave a detailed account of biological races occurring among the pathogenic Protozoa of man and domestic animals. They were there defined as ‘ such subdivisions of a morphological species as are distinguishable by differences in biological characters only ’, and it was suggested that their taxonomic status should be formally recognized.

I now propose to discuss this question more fully. Among the parasitic protozoa there are numerous examples of morphologically identical groups which differ from each other only in biological features, especially in host-parasite relations. Though known collectively as ‘ biological races ’, these groups are not all homogeneous in constitution and are therefore not equivalent: they differ both in their mode of life and in the constancy of the biological characters separating them from each other. Thus, trypanosomes and spirochaetes can rapidly adapt themselves to successive antibodies produced by the host in the course of an infection, by forming a series of ' relapse strains ' (Ritz, 1916). These strains represent transient populations, which are immunologically distinct and differ antigenically. Since their antigenic structure is subject to variation which is environmentally induced, relapse strains are comparable to enduring modifications (*Dauermodifikationen*). A higher degree of stability is achieved by races that differ in virulence. Some of them have a wide range of mammalian hosts, but show a preference for a limited number. Thus, in different parts of the world there are equine, bovine and cameline strains of *Trypanosoma evansi* causing the disease Surra (Hoare, 1943) ; and there are hostal races of *Plasmodium*, common to man and chimpanzee but more strictly adapted to one of these hosts, in which they produce malaria (Reichenow, 1939). Other races differ in virulence for the same host, like the varieties of *Theileria* which are responsible for at least three forms of East Coast fever in cattle (Carpano, 1937). Finally, there are a number of races which have been under practically continuous observation for periods up to half a century without manifesting any change. Since in the history of a micro-organism this amounts to almost eternity, we are justified in concluding that such races have stood the test of time. They are undoubtedly stable and hereditarily fixed groups, like the conventional systematic units with constant morphological characters. The best known examples are African trypanosomes of the *brucei* group, usually designated as three species. Two of them, *Trypanosoma gambiense* and *T. rhodesiense*, causing the chronic and acute variants of Sleeping Sickness in man are probably identical, whereas the third, *T. brucei*, causes the disease Nagana in ungulates but is incapable of infecting man. These races of trypanosomes are thus characterized by narrow host-restriction. Other Haemoflagellates inhabit the same host but produce in it distinct diseases. Thus, in equines diseases of two types are produced by morphologiclly identical trypanosomes : one, due to *T. equiperdum*, is a venereal disease, Dourine, which affects the tissues ; the other, Surra, is a blood infection due to *T. evansi*. While the former is transmitted directly, by contact, the latter is transmitted by blood-sucking insects. Similarly, *Leishmania donovani* produces in man a generalized visceral infection, known as Kala-Azar, whereas *L. tropica* gives rise to a localized cutaneous infection called Oriental Sore. Lastly, the human malaria parasites, *Plasmodium vivax* and *P. falciparum*, are each represented by a number of hostal and geographical strains : though producing the same type of disease, they differ from each other immunologically, in their response to drugs, and in the choice of Anopheline vectors. These differential characters are firmly fixed and retained in the course of an indefinite number of passages through man and mosquito (Boyd, 1940).

I now turn to the taxonomic treatment of biological groups in the Protozoa. At present they have no accepted status, but are loosely called races, strains, types, or even species. However, the specific names attached to certain races of pathogenic protozoa (some of which have been mentioned above) are not based on the recognition of the validity of biological criteria in taxonomy, but are the result of a classification determined by the clinical and pathological aspects of the diseases caused by the parasites. This anthropocentric approach to systematics is obviously untenable, but it is highly desirable to introduce order and uniformity in the classification and nomenclature of biological races. The formal recognition of their taxonomic status is not merely an academic question but is also of practical interest, since the exact determination of a parasite or a pest is of the greatest importance in human and veterinary medicine, as well as in agriculture. Probably the neglect of biological races in the past was due mainly to the fact that the classification accepted by most systematists was based entirely on the degree of morphological divergence, and did not make any provision for groups in which the differential characters are physiological or ecological. However, recent work in genetics and systematics has considerably widened our conception of the methods of speciation. It is generally held that taxonomic differentiation is determined by isolation. From this point of view, there is no fundamental difference between geographical races of free-living organisms and biological races of parasites. Whereas perpetuation of the former is ensured by spatial segregation, in the latter it is brought about by differences in the mode of life (Semenov-Tian-Shansky, 1910 ; Thorpe, 1930 ; Huxley, 1940, 1942 ; Wilmott, 1949). This view is also supported by the fact that the genetical mechanism responsible for variation leading to biological divergence is of the same order as that producing morphological divergence (Dobzhansky, 1941 ; Mayr, 1942). It has also been established that in some groups of animals (e.g. *Drosophila*) evolutionary divergence is not accompanied by morphological change, whereas in others it is (Dobzhansky, 1946). From these facts it is evident that both biological and morphological attributes can be used as equivalent taxonomic criteria. This being so, there is no necessity—as I formerly believed (Hoare, 1943)—to introduce a new systematic unit for the reception of biological races, but these can be included in the conventional systematic categories.

The use of the same nomenclature for all groups of organisms, irrespective of whether the differential criteria are biological or morphological, ensures a uniform system of classification, without depriving it of elasticity. Thus, it solves the difficulty of classifying such races which, in addition to considerable biological differences, display slight structural differences. It also permits inclusion in the same category of morphologically identical organisms represented by parasitic and non-parasitic races (as in the case of the dysentery amoeba, *Entamoeba histolytica*, and its free-living counterpart, *E. moshkovskii*). Further, the status of a set of biological races will not be affected by subsequent detection of structural differences between them (as in the case of some races of plant-lice : cf. Hoare, 1943). Though biological and morphological races can be assigned to the same systematic unit, it would be desirable for practical reasons to indicate by some symbol the nature of their divergence (cf. Huxley, 1942 ; Wilmott, 1949).

It is now necessary to consider the exact rank which should be attached to biological races. Though regarded as equivalent for taxonomic purposes, biological and morphological groups are not necessarily on the same level of speciation. In fact, there are plausible grounds for regarding physiological divergence as an earlier stage of this process. We have already seen that among parasitic protozoa purely biological groups may differ in the degree of stability. Thus, relapse strains provide an example of initially transient differentiation, which is later stabilized in hereditarily fixed biological races. These, in their turn, may show a gradation in structural divergence, starting from morphologically indistinguishable races (Hoare, 1943), through races differing in cryptic cytological characters (e.g. *Drosophila* : Dobzhansky, 1942), to races in which minor external differences have made their appearance (cf. Thorpe, 1930, 1940). From these facts it can be assumed—at least as a working hypothesis—that in some cases the initial stage of variation is manifested by invisible physiological changes, to which—in the course of evolution—visible morphological changes may subsequently be added (Robson & Richards, 1936 ; Uvarov, 1939 ; Huxley, 1942). Until this level is reached, biological races should be treated as intraspecific units which—like geographical races—represent incipient species. Those biological races which are hereditarily fixed can be classified as subspecies, while those which are environmentally induced and unstable are equivalent to morphae.

Finally, it may be pointed out that although I have restricted this discussion to parasitic protozoa, the conclusions arrived at can also be extended to biological races among other animal parasites (both entozoic and ectozoic), as well as to types among bacteria, and to some ecological races among free-living organisms.

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BIOLOGICAL RACES AND THEIR TAXONOMIC TREATMENT BY MYCOLOGISTS

By Dr. R. W. G. DENNIS.

When a mycologist speaks of biological races he is almost invariably thinking of parasitic fungi and probably of the cereal rusts. It was in these obligate parasites that the existence of biological races able to attack only a single host species was first conclusively demonstrated independently by Eriksson in Sweden and by Hitchcock and Carleton in Kansas. This was in the last decade of the nineteenth century. In the case of the old *Puccinia rubigo-vera* (DC.) Wint. Erikson and Hennings were able to demonstrate that the name covered two morphologically separable entities which they called *Puccinia glumarum* and *P. dispersa*. But in *Puccinia graminis* and *P. coronata* no morphological differences were detected between the races found to be confined to individual species of cereals and grasses. These morphologically similar host-limited races they therefore called ' formae speciales '. Of these they ultimately recognized seven in *Puccinia graminis*, namely F. sp. *Secalis, Avenae, Tritici, Airae, Agrostis* and *Poae*. These were not all completely restricted to the host genus from which they were named, thus F. sp. *Secalis* could attack *Hordeum* and *Agropyron* as well as Rye. Carleton accepted Eriksson's nomenclature in principle but simplified it to a trinomial form, thus, *Puccinia graminis tritici, P. graminis secalis, P. graminis avenae.* Although frowned upon by nomenclatorial pundits this use of trinomials in such cases has proved extremely popular and convenient, especially in non-taxonomic literature and has persisted both in North America and in Europe. Clearly it is no more than a nomenclatorial variant and implies no fundamental difference in outlook as regards the status of the races. Thus Arthur in his monograph of North American rusts adopted the trinomial nomenclature but referred to them as ' Physiologic races ', not as varieties or subspecies.

Cereal rusts are heteroecious and the biological races of *Puccinia graminis* so far mentioned can be distinguished only in their uredo dicaryophase which corresponds rather imperfectly to the sporophyte of a vascular plant. They all have indistinguishable aecidial gametophytic states on the same alternate host *Berberis vulgaris*. Eriksson and Hennings, however, discovered an eighth race of *Puccinia graminis* on *Phleum pratense* which was unable to infect *Berberis vulgaris*. This they considered worthy of specific rank and described under the name *Puccinia phlei-pratensis* Eriks. & Henn. It seems clear that their reason for regarding the *Phleum* race as worthy of specific rank lay in its inability to infect the usual aecidial host, that is, in a biological not a morphological character. Subsequent workers have claimed, however, that both the spore forms and the mycelium of *Puccinia phlei-pratensis* are consistently smaller than those of *Puccinia graminis*, thus providing some morphological basis for the species. American authors have latterly reduced it to varietal rank as *Puccinia graminis* var. *phlei-pratensis* (Erikss. & Henn.) Stakman & Piemeisel.

A similar situation was discovered by Klebahn among the crown rusts of oats and grasses known collectively as *Puccinia coronata* Corda. Within this aggregate he claimed to have differentiated two species based on their restriction to different aecidial hosts, namely *Puccinia coronata* Corda sensu stricto, with aecidium on *Rhamnus frangula* and uredo stage on *Dactylis* and *Festuca silvatica*, and *Puccinia coronifera* Klebahn with aecidium on *Rhamnus cathartica* and uredo stage on *Lolium*, *Avena* and *Festuca elatior*. For those who regard different aecidial hosts as justifying species-mongering in rusts Klebahn's views have no doubt been confirmed by the modern tendency of taxonomists to place these two buckthorns in separate genera and to rechristen *Rhamnus frangula* as *Frangula alnus*. Subsequently Klebahn recognized eleven formae speciales of these crown rusts, namely *Puccinia coronata calamagrostidis* Erikss., *P. coronata phalaridis*, *P. coronata holci* Kleb., *P. coronata agrostis* Erikss., *P. coronata agropyri* Erikss., *P. coronifera avenae* Erikss., *P. coronifera lolii* Erikss., *P. coronifera festucae* Erikss., *P. coronifera holci* Kleb., *P. coronifera alopecuri* Erikss. and *P. coronifera glyceriae* Erikss.

So far the taxonomic treatment of biological races in rusts was reasonably consistent, if a morphological difference could be detected it justified elevating a race to specific rank, if there was no clear morphological difference between races they remained formae speciales. But there was one inconsistent note, this treatment applied only to the dicaryophase. If two races differed in the hosts of their gametophytic phase there was an evident desire to regard them as different species. There seems no obvious reason for this and when the tendency to do so was applied outside the cereal rusts a rather unfortunate nomenclatorial confusion arose, both in the species of *Melampsora* on *Salix* and *Populus* and in *Puccinia* on *Carex*. Among the former, for example, the old *Melampsora tremulae* Tulasne with uredo and teleutospore states on *Populus tremula* was divided into *Melampsora laricitremulae* Kleb. with caeomata on *Larix*, *M. pinitorqua* Rostrup with caeomata on *Pinus sylvestris*, *M. rostrupii* Wagner with caeomata on *Mercurialis perennis* and *M. magnusiana* Wagner with caeomata on *Chelidonium*. These rusts cannot be separated with confidence in their dicaryophases on *Populus* but instead of regarding them as formae speciales Klebahn and his school have given them all binomial names as species. Similarly the old sedge rust *Puccinia caricis* has been split up into *P. caricis* with aecidia on *Urtica*, *P. pringsheimiana* Kleb. with aecidia on *Ribes* and *P. paludosa* Plowright with aecidia on *Pedicularis*. Morphologically these are indistinguishable and there seems to be a tendency among modern rust specialists to regard them as biological races of a single species. Thus as long ago as 1934 Jørstad wrote ' I follow the usual practice not as a general rule to unite heteroecious rusts with aecidia on members of different host families or not closely related host genera. In case one would unite the three *Carex* rust species first mentioned, which really seems justifiable enough, the name *Puccinia caricis* (Schum.) Duby might perhaps be serviceable for the collective species in question'. Nevertheless British mycologists and especially plant pathologists, still refer to the common gooseberry rust as *Puccinia pringsheimiana*. On the other hand Arthur in North America reduced the *Urtica* and *Ribes* rusts to varietal rank as *Puccinia caricis* var. *urticata* and var. *grossulariata* but claimed that all the spores of the latter are as a rule smaller than those of the former. The problem is complicated by a lingering uncertainty as to the biological fixity of the *Urtica* and *Ribes* races, varieties or species. According to Arthur there are exceptional cases in which the measurements of *P. caricis grossulariata* spores equal those of *P. caricis urticata* and one can surmize that they may have been derived from a strain that would infect both *Ribes* and *Urtica*. In Klebahn's cultures teliospores from *Carex acuta* occasionally produced aecia both on *Urtica* and *Ribes* but he explained this away as due to the use of mixed inocula or to contamination from stray spores. The latter is always difficult to exclude in rust inoculations but similar observations have been made by subsequent workers. This difficulty in obtaining absolutely dependable experimental data about biological races seems a good reason for caution in expressing the experimental results in taxonomy unless they can be supported by tangible morphological differences.

A somewhat different situation has been described in the brown rusts of cereals. We have already seen that, at the outset of his cereal rust studies, Eriksson was able to divide *Puccinia rubigo-vera* into *P. glumarum* and *P. dispersa*. The latter segregate was subsequently shown to comprise several biological races, each confined to one species of cereal or grass, and in 1899 Eriksson raised these to specific rank on the assumption that they would be found to have different aecidial hosts, though at that time only the aecia of the race on *Secale* were known. This assumption has largely been justified by subsequent research so that we have seven morphologically indistinguishable rusts which differ from one another both in aecidial and uredo-teleutospore hosts as far as known.

These are :—

Puccinia dispersa Erikss. on *Secale cereale* and *Anchusa arvensis*.
Puccinia bromina Erikss. on *Bromus* spp. and *Symphytum officinale*.
Puccinia triticina Erikss. on *Triticum vulgare* and *Aquilegia* spp.
Puccinia simplex Erikss. & Henn. on *Hordeum* and *Ornithogalum* spp.
Puccinia agropyrina Erikss. on *Agropyron repens* and *Clematis* or other *Ranunculaceae*.
Puccinia holcina Erikss. on *Holcus*.
Puccinia triseti Erikss. on *Trisetum flavescens*.

The aecidial hosts of the last two species are as yet unknown but it will be noted that those which are known occur on widely separated host families, Boraginaceae, Ranunculaceae and Liliaceae in spite of the obvious close relationship of the rusts concerned. It is obviously convenient to have distinctive names for fungi which are as easily recognized and strictly host-limited as these appear to be but there has been persistent opposition to Eriksson's nomenclatorial solution of the brown rust problem. This opposition has come mainly from American authors, on two grounds. First it may be contended that when Eriksson and Hennings distinguished two species within the old *Puccinia rubigo-vera* they should have retained that name for one of them. Secondly there has been a strong tendency to deny specific rank to these morphologically similar rusts and to regard them rather as biological races of *Puccinia rubigo-vera*. Such a treatment is particularly appropriate to continental areas outside Europe, where numerous brown rusts of grasses exist whose aecidial stages and host specialization are imperfectly known.

Thus within a dozen years of the first recognition of biological specialization in the rusts an arbitrary but convenient taxonomic convention had been established, namely, if two morphologically identical rusts have different hosts both in aecidial and uredo-teleuto stages or in aecidial stage only they are regarded as distinct species ; if they differ only in the host of the uredo-teleuto stage they are biological races of a single species. We have already seen that this arbitrary solution is breaking down in the *Carex* rusts and it would probably have been abandoned in the *Melampsoras* if more experimental work had been undertaken on the group. As long as ago 1913 Grove protested that ' The morphological differences of the four species of *Melampsora* which occur on *Populus alba* and *P. tremula* are very slight. It is better to include them all for the present under *Melampsora tremulae* as biological races '. Nevertheless in the absence of further detailed experiments the weight of Klebahn's authority has been sufficient to impose his elaborate species complex in *Melampsora* on mycological literature to the present day.

Unfortunately the arbitrary taxonomic solutions of Eriksson and Klebahn have to face results from other directions. In the first place, more refined observations have thrown doubt on the morphological identity of their formae speciales. Secondly, the biological specialization of the fungi has proved far more intricate than they thought. When an author states that two races of a rust are morphologically indistinguishable, one has to remember that because of their small size and simple thallus rust fungi have far less opportunity of expressing morphological differences than have flowering plants. Hence the great importance attached by mycologists to mere dimensions and mean spore sizes. As long ago as 1923 Levine concluded that ' spore measurements can be employed as an additional aid in identifying the biologic forms of *Puccinia graminis* provided a sufficiently large number of spores are measured for both length and width and the spores studied are developed on congenial hosts under favourable conditions '. More recently Guyot has attempted an independent division of *Puccinia graminis* into subspecies and varieties with a statistical basis alone. He has thus proposed an entirely new nomenclature with three subspecies and seven varieties. It is too early to say how far this may prove an acceptable solution of the long-standing problem or whether, indeed, the mean spore sizes on which his classification rests are constant and dependable characters. A further complication is the possibility of variation in spore size of biological races within the old formae speciales. Intensive research has shown that all the formae speciales of economic importance in the cereal rusts consist of a large number of races recognizable by their different capacity for parasitizing individual cultivated varieties of the host plant. As long ago as 1935 Stakman and his collaborators in North America provided keys for the determination of 144 such races or biotypes within *Puccinia graminis tritici*. By now about 300 biotypes have been recognized within this forma speciale and between some of them there are appreciable differences in mean uredospore size. Thus race 1 on a congenial host has uredospores $34{\cdot}8 \times 20{\cdot}2\mu$ in mean dimensions and race 29 has them only $28{\cdot}7 \times 19{\cdot}4\mu$, i.e. not only smaller but relatively shorter and more rounded. No attempt has ever been made to find a place for these biotypes in the taxonomic scheme. They hybridize readily on the aecidial host, giving rise to new biotypes, and are distinguished when necessary by numbers which merely indicate the order in which they were discovered. As Gaumann has pointed out, identification of these biotypes depends on the possibility of maintaining the diagnostic host varieties indefinitely in pure lines. Before leaving this subject it may be well to remark that though only a few rusts of economic importance on cultural crops have been investigated in detail it may be assumed that similar biological races and biotypes occur in both parasite and host in wild populations. Thus d'Oliviera found two races of *Ornithogalum pyrenaicum* in Portugal, one of which could bear aecia of *Puccinia hordei* Otth, while the other was immune to the races of the fungus tested. Similarly in seedlings of *Ornithogalum nutans* he found all degrees of susceptibility to the rust gametophyte, from perfect congeniality to a very sharp necrotic hypersensitive reaction.

Unfortunately in other groups of rusts mycologists have shown much less restraint in multiplication of specific names. *Puccinia bullata* (Persoon) Winter is a rust which occurs as a collective species on many genera of Umbelliferae. Lindroth distinguished about thirty-three allied species on minor morphological characters and redefined *Puccinia bullata* as a rust attacking *Cenolophium, Cnidium, Laserpitium, Peucedanum, Selenium, Seseli* and *Silaus*. Two years later Semadeni showed that the rust on *Peucedanum palustre* was a specialized biological race but he had the restraint to forbear christening it with a new bionomial. Quite recently Gaumann has re-examined this race and its allies and has found small differences in mean dimensions of 200 uredospores. On this basis he has erected for it the new species named *Puccinia semadenii*. Clearly by analogy with the current treatment of *Puccinia graminis* this is worthy of at most varietal rank.

In the cereal smuts the taxonomic position is somewhat less involved, partly because it is not complicated by the phenomenon of heteroecism. Early mycologists recognized an *Ustilago segetum* (Bulliard) Winter, causing smut of the inflorescences in *Avena, Triticum, Hordeum* and *Arrhenatherum*. Jensen and Rostrup in Denmark split up this collective species into a covered smut, *Ustilago hordei* on Barley and into four morphologically indistinguishable loose smuts, distinguished by their restrictions to host genera, named *Ustilago avenae* on oat, *U. nuda* on barley, *U. tritici* on wheat and *U. perennans* on *Arrhenatherum*. Subsequent work showed that minute morphological differences could be detected between some of these segregates and furthermore that *Ustilago avenae* could be divided into two morphologically distinct species, *U. avenae* with rough spores and *U. kolleri* Wille with smooth spores. Much more recently *Ustilago nuda* was divided into *U. nuda* and *U. nigra* Rapke which differ especially in the method of germination of the chlamydospores. In place of *Ustilago segetum* there were thus seven species, some differentiated on morphological, others on purely biological grounds. In a recent critical study Fischer has proposed to consolidate these into three morphologically distinguishable species, each including more than one biological race restricted to a single host genus, namely

Ustilago avenae (Persoon) Rostrup, including beside loose smut of oats, the morphologically indistinguishable races formerly called *Ustilago perennans* Rostrup on *Arrhenatherum* and *Ustilago nigra* Tapke on barley.

Ustilago hordei (Persoon) Lagerheim, covered smut of barley, including the morphologically indistinguishable race on oats formerly called *U. kolleri* Wille.

Ustilago tritici (Persoon) Rostrup on wheat, with the morphologically indistinguishable race formerly called *Ustilago nuda* (Jensen) Kellerman and Swingle on Barley.

Several biotypes distinguishable by their capacity for parasitizing only a few cultivated varieties of the host have been recognized within each of these smuts and are designated by numbers as in the rusts. Fischer's revision of the loose smuts is logical and mycologically acceptable and is followed by Ainsworth and Sampson in their recent book on British smuts.

It is noteworthy, however, that the species divisions recognized on minor morphological characters cut across those originally recognized by Jensen from pathogenicity studies. In the case of such economically important fungi this raises a practical difficulty. It is obviously much simpler and more convincing for a plant pathologist to tell a farmer that his barley is infected with *Ustilago nuda* and his wheat by *U. tritici* than to tell him both are infected by *U. tritici* but that the *U. tritici* on the barley is not the same as that on the wheat and cannot attack the latter crop.

The taxonomic history of the powdery mildews has been somewhat different. Nineteenth century mycologists described a large number of species and varieties based mainly on the occurrence of the fungi on different host genera. In 1900 the whole family was ably monographed by Salmon who recognized species solely on a morphological basis and thus reduced their number from 131 to 49 with eleven named varieties. This achievement put the nomenclature of the group on a sound basis before any extensive series of cross-inoculations was undertaken and has been adopted by most authors to the present day. In Europe a modified form of this system devised by Blumer has become popular. Blumer recognized several additional species on purely morphological grounds. Biological races and forms have been demonstrated within several of the species and have received the same taxonomic treatment as those of the rust. Thus in 1902 Marchal recognized within *Erysiphe graminis* De Candolle formae speciales *tritici, hordei, secalis, avenae, poae, agropyri* and *bromi*. Twenty years ago Mains distinguished five physiological forms within forma specialis *hordei* and soon afterwards two within forma specialis *trici*. These have had no taxonomic recognition.

With the downy mildews, Peronosporaceae, there is a comparable situation in which morphologically easily recognized species are credited with wide host ranges. Thus *Peronospora parasitica* (Persoon) Fries has been recorded on over 100 species in 44 genera. As a result of cross-inoculations and statistical studies of spore and conidiophore dimensions Gaumann in 1918 distinguished within this collective species 52 taxonomic units which he raised to specific rank. There can be little doubt most of these are comparable to the formae speciales of Eriksson and Marchal or to the subspecies and varieties of Guyot and very few of them have been adopted by subsequent authors.

In these families, Uredinaceae, Ustilaginaceae, Erysiphaceae and Peronosporaceae, all fungi of considerable economic importance and all except the second obligate parasites, there exists abundant experimental evidence of the existence and relationships of biological races, and the taxonomist's problem is to evolve a workable and consistent treatment of the data provided by the plant pathologists. In many other groups of fungi, however, the situation is reversed ; the taxonomic treatment has developed without any experimental background and the result is a chaotic assemblage of ' host species '. Thus in the Sphaeropsidales in addition to the few available morphological criteria, including size, shape and colour of pycnidia and spores much stress has been placed on the host plant or other substratum. As a result there are over 1700 so-called ' species ' in *Phoma* alone so that it has been well said that ' to refer a species to *Phoma* at present is little more than an ignorance of the organism in hand or its relationship '. A similar situation obtains in the Hyphomycete genera *Ramularia* and *Cercospora*. In the latter especially it has been assumed that forms found on different host genera are to be treated as distinct species. Usually they are scarcely distinguishable morphologically and there is no experimental evidence to show that they are even biological races. This treatment is quite inconsistent with modern trends in taxonomy of rusts and smuts and it would appear that if mycologists are to be consistent there will be very extensive fusion of species in Sphaeropsidales, *Cercospora, Ramularia* and the like genera.

Biological differences between races of fungi are not, of course, restricted to their capacity for parasitizing Phanerogams. Differences in other non-morphological characters have, however, been less publicized and authors have been less eager to give them taxonomic expression. It is well known that the morphological species of *Aspergillus* and *Penicillium* comprise a multitude of races with different chemical properties, including enzyme production and pigmentation. Buller claimed that American examples of the Agaric *Panus stypticus* (Bull.) Fr. were morphologically indistinguishable from those in

Europe, but were biologically distinct because the American fungi had luminous sporophores and mycelium whereas those found in Europe were non-luminous. For the American form he proposed the name *Panus stypticus* forma *luminescens* Buller. Similarly Corner has noted that tropical collections of *Mycena rorida* (Fr.) Quélet give a luminous spore print which has not been observed in European collections. For the tropical material he proposed the name *Mycena rorida* var. *lamprospora* Corner. But this is perhaps not a purely biological race as it appears to have more consistently 4-spored basidia, and hence slightly smaller spores, than the typical temperate race of the species.

In conclusion it is probably fair to say that in those groups of fungi which have been most studied the current tendency of taxonomists is to insist on a morphological basis for species and varieties. There is room for difference of opinion as to the value to be attached to small differences in mean spore sizes but the modern trend is towards rejection of species based on differences in gametophytic hosts of heteroecious rusts.

Opposition to these trends comes mainly from two sources. First there is the plant pathologist who finds it desirable to have distinctive names for different parasites even if they look alike under the miscroscope. His is a practical problem with which one is bound to sympathize, and it may be that the nomenclature of the practising pathologist and the herbarium mycologist will never quite coincide. If it is to do so forbearance will probably be called for on both sides. The other source is the enthusiast who wants mycological nomenclature to reflect his latest discovery and experimental data. Pests like these are always with us and there is probably no hope of controlling them. But one may point out that the latest split and the latest name are not necessarily the best or even the nearest to the truth. The advantages of conservatism both in speciation and nomenclature are well shown by the history of the *Carex* rusts where *Puccinia caricis* after division into three species with different gametophytic hosts is being quietly re-adopted by the most advanced and experienced students of the Uredineae.

THE PROBLEM OF BIOLOGICAL RACES IN THE *CULEX PIPIENS* COMPLEX

By P. F. Mattingly, British Museum (Natural History).

The subject of this paper is a mosquito known as *Culex molestus* Forskål. It belongs to a small group known as the *Culex pipiens* complex. The best known members of this complex are *Culex pipiens* Linnaeus, the 'Common Gnat', which is found throughout most of the holarctic region and in some of the cooler parts of the tropics and *Culex fatigans* Wiedemann, which is cosmotropical. Until very recently these have been regarded as distinct species since they differ in some of their habits (*pipiens* undergoes hibernation and does not bite man while *fatigans* bites man and is apparently incapable of hibernation) and in the structure of the male terminalia, usually considered a strong character by mosquito taxonomists. As long ago as 1926, however, it was suggested that they were hybridizing subspecies. This suggestion was based on the occurrence of forms intermediate with respect to their male terminalia in California, where the range of *pipiens* and *fatigans* overlaps. Similar intermediates occur in the corresponding region of overlap in China and southern Japan, and one or more of these forms appears to have been introduced into southern Australia and interbred with the local *fatigans*. Recent work on the forms occurring in the southern United States has lent strong support to the supposition that *pipiens* and *fatigans* interbreed in nature in this region. In the laboratory they will cross readily in either direction with the production of intermediate forms apparently identical with those found in nature, and males of both forms appear to select females of either form at random when they are given a choice. The latter point is important since it is known that some species of mosquitoes, which can be crossed in the laboratory with the production of hybrid offspring, exhibit an exclusive preference for mates of their own species when given a choice and this is thought to constitute a natural barrier to hybridization. Other studies based on certain physiological characters and on precipitin tests, using the ground-up mosquitoes as antigens, and on the comparative ability to transmit certain virus and filarial parasites have failed to reveal any differences which might be considered to be of specific order. (For a full discussion see Mattingly *et al.*, 1951).

The position of *molestus* in relation to this complex is obscure. It resembles *pipiens* so closely with respect to the male terminalia as to be virtually identical, and other morphological and colour characters which have at various times been proposed for separating them appear to be of local validity only. With respect to behaviour, however, it shows a closer resemblance to *fatigans* since it readily bites man and is incapable of hibernation. It appears to have been the man-biting habit together with its rather conspicuously pale colour that mainly attracted Forskål's attention and led him, in 1778, to describe it as a distinct species. Edwards in his revision of the Palaearctic mosquitoes, published in 1921, preferred to treat it as no more than a variety, but a few years later the detection of another rather striking biological difference from *pipiens* led to an urgent clamour for its restoration to specific rank. This difference consists in the fact that *molestus* is autogenous, that is to say, it can produce viable eggs without a preliminary blood meal ; *pipiens* is anautogenous and cannot. After the discovery of this difference search was made for others and some were soon found. Thus *molestus* was found to be stenogamous, i.e. capable of mating in very small cages ; *pipiens*, on the other hand, is eurygamous. *molestus*, as has already been stated, is homodynamous, i.e. it fails to undergo gonadotrophic dissociation at the onset of winter with formation of a fat-body and complete hibernation. *pipiens* is heterodynamous. *molestus* breeds mainly in underground water, *pipiens* above the ground, and *molestus* lays a smaller egg raft. The fact that the two forms will, in general, cross quite readily in the laboratory seems to many people to be of little significance beside these differences in biological characters. and *molestus* became commonly accepted as a distinct species. Some persons, however, remained unconvinced.

In the light of more recent work it would seem that the doubters were justified. The character of autogeny, on which so much reliance was placed, has been shown to behave in crossing experiments as a simple mendelian recessive. Laven, who has studied the *pipiens* of northern and central Germany, is of the opinion that the gene in question is freely shared between *pipiens* and ' *molestus* ' in nature and undergoes a seasonal fluctuation in concentration, being maintained in the population, during winter, mainly in the heterozygous condition in which it is carried by hibernating *pipiens*. Work on topotypical populations of *molestus* in Cairo suggests that even here only a small fraction of the wild population is autogenous. A factor which may have caused confusion in the past is the unconscious selection exercised by those working with cage colonies. It is clear that in such colonies recessive characters of the kind under discussion may easily be favoured more than in nature. The other biological characters of '*molestus*' have not been so fully investigated as autogeny but an examination of the literature reveals the highly suspicious fact that no two of them are constantly associated. Thus from the United States we have a man-biting form which breeds above ground like *pipiens* and a non-man-biting form which, like *molestus*, is autogenous, whereas from France we have man-biting, eurygamous and non-man-biting stenogamous forms. It is clear, therefore, that, as in the case of the morphological characters, the association of all the biological characters supposed to typify *molestus* is a local phenomenon only. Such an association appears to have been clearly demonstrated only in populations occurring in large cities and I have therefore suggested (Mattingly *et al.*, in press) that it should be treated as an urban biotype and given some relatively noncommittal name such as form or var. *molestus*. As a general principle I should regard this as unsound but it seems that those who are responsible for the control of mosquito nuisances in our cities, where *molestus* can be a serious or even perhaps, in parts of its range, a dangerous pest, feel that they can do their work better if they have the use of a separate name. It is probable that when the situation is more widely understood the demand for a name will die down. In the meantime the important need is to ensure that the use of this or any other name is not allowed to obscure the necessity for a broad genetical approach to the problem. Whatever may be the true status of *molestus* it is virtually certain that it is not a reproductively isolated species. It represents rather the manifestation of certain inherent genetical potentialities in the *pipiens* population, the nature of which, in any locality, reflects the selective action of the environment. It is clear that phenomena of this kind can only be studied with profit by the methods of population genetics. We must concern ourselves with the seasonal and geographical distribution not of names but of particular biological or morphological characters, and we must seek to understand the distribution of these characters in the species population as a whole in terms of their genetical background.*

Reverting, finally, to the *pipens* complex as a whole, it is interesting to speculate to which species, *pipiens* or *fatigans* (supposing that we intended to maintain them as distinct species) we ought to attach the name var. or form *molestus*. The male terminalia of *molestus* are virtually identical with those of *pipiens* and superficially quite distinct from those of *fatigans* and for this reason nobody would previously have hestitated to treat *molestus* as a form of *pipiens*. From the work carried out on the *pipiens* complex in the United States, however, it is not at all certain that the intermediate forms occurring there are solely the product of natural hybridization. It seems possible that where their geographical ranges overlap *pipiens* and *fatigans* may tend to converge with respect to the structure of their male terminalia. If this is indeed the case then we may yet find that the biological resemblance of *molestus* to *fatigans* affords a better indication of its true affinities than its morphological resemblance to *pipiens*. This, however, is for the future to decide.

REFERENCE.

MATTINGLY, P. F., ROZEBOOM, L. E., KNIGHT, K. L., LAVEN, H., DRUMMOND, F. H., CHRISTOPHERS, S. R., and SHUTE, P. G. (1951). *The* Culex pipiens *Complex*. (Trans. R. ent. Soc. Lond., **102**, 331–382.

In opening the discussion, the PRESIDENT remarked that, since most of the speakers had dealt especially with parasitic organisms, he would mention that amongst unicellular algae many examples of biological races, distinguished essentially by physiological characteristics, had become known. This was so, for example, in the genus *Trebouxia* (perhaps more familiar to many by the name of *Cystococcus*), where R. Chodat and his pupils had shown the existence of large numbers of such biological races in pure cultures, although only a few of them could be separated by morphological features.

Mr. P. C. SYLVESTER BRADLEY said that all speakers had emphasized two different criteria for the determination of the taxonomic status of biological races :

1. the degrees of morphological differentiation (as apart from the physiological differentiation discussed) ;

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* Recent cross-breeding experiments by Dr. Laven have lent some colour to the suggestion that '*molestus*' may represent a complex of sibling species. See Mattingly *et al.*, Trans. IXth Int. Congr. Ent., In Press.

2. the degree of isolation achieved, more especially in parasitic organisms restricted to certain hosts.

The same criteria are adopted in zoological taxonomy when it becomes necessary to consider whether a geographical race should or should not be classed as a subspecies. If morphological differentiation is detectable and the population is isolated, it is permissible to erect a subspecies. Biological differences present in organisms which in their gross morphology are otherwise indistinguishable must be based on some morphological distinction, even if this is ultra-microscopic. There would seem to be no need to erect a new systematic category to care for biological races. As Dr. Hoare suggests, should they be worthy of nomenclature at all, they can take their place as subspecies. Thus Mr. Mattingly's three mosquitoes could all be regarded as subspecies of one species.

The case of those biological races which show a varying degree of specificity to a single host in different parts of their geographical range recalls the problem raised by the two categories of ' ecotype ' in botanical taxonomy. Allopatric ecotypes share both a different ecological habitat and a different geographical range. They can be classed as geographical races with subspecific rank exactly as is the common practice with polytypic species of animals. Sympatric ectotypes on the other hand, differ in character and status from geographical races. Living in adjacent habitats with differing environmental conditions they are often connected by a cline. Even so, Clausen and his colleagues rate such ecotypes as subspecies.

Dr. D. R. MELVILLE suggested that heterostyly in flowering plants could be considered as a special kind of biological race and mentioned some recent work by F. Moevius. (Biol. Zentr., **69**, 1950 (18), 1–96) on the biochemistry of the heterostylic forms of *Forsythia intermedia.* Each form contains in the pollen a glycoside which inhibits pollen germination on its own stigma but not on that of the opposite form, while the stigmas contain an enzyme capable of hydrolyzing the glycoside in the pollen of the opposite form, but not of their own. Cross pollination of the two forms is thus very effectively provided for. If, however, the pollen is treated with a dilute solution of a boron compound, then pollen of either kind will germinate on the stigmas of both long-styled and short styled flowers. In some way boron removes the inhibition to pollen germination of both glycosides. This is a remarkable example of a biochemical control imposed by a single element. It suggests the possibility that comparable mechanisms underlie the differentiation of other biological races such as, for example, those developing distinctive essential oils.

Prof. T. G. TUTIN : It appears from what has been said that biological races are groups of organisms which are scarcely distinguishable morphologically but differ from each other in some less obvious ways. Such groups range from those which are quite interfertile to those which are largely or even completely intersterile. There seem, therefore, to be two ways of treating them taxonomically depending on whether we pay most regard to principles or practical convenience. In principle groups which are interfertile though not normally interbreeding, owing to more or less complete isolation of one kind or another, could be regarded as subspecies ; groups which are nearly or quite intersterile should be regarded as species. From the point of view of the systematist and morphologist there are practical disadvantages in this treatment, and it seems to me that it is for this reason that the term ' Biological Race ' was invented. To the geneticist and physiologist, on the other hand, it is inconvenient to include these very different kinds of groups under a common heading, thus concealing their nature and making it impossible to equate them with other groups of organisms which happen to differ from one another morphologically as well as genetically and physiologically.

Dr. O. W. RICHARDS asked Mr. Mattingly whether it was not the case that *Culex molestus* and *C. pipiens* were easy to distinguish in England and whether perhaps some of the taxonomic difficulties that had arisen might not be due to the attempt to apply the name *molestus* to a variety of forms in different countries.

In reply Mr. BURTT said that as Prof. Tutin had referred to polyploidy, he might mention the case of *Galax aphylla* (Baldwin in Journ. Hered. **32,** 249: 1941). In this American species of Diapensiaceae the diploid and tetraploid races occurred in the same area and could only be distinguished by the greater vigour of the latter. In this case, then, there were coincident physiological and cytological races.

Mr. Sylvester Bradley had mentioned ecotypes and subspecies. It was necessary to point out that the ecotypes of *Pinus* and *Phleum* lay far below the taxonomic level of subspecies. Were such physiological ecotypes to be named, the taxonomist would be swamped.

Dr. O. W. Richards had suggested that *Culex molestus* was effectively a good species in Britain, whatever happened elsewhere. On a normal morphological basis of species many parallels to this could be found in flowering plants. For instance *Veronica anagallis-aquatica* and *V. catenata* (till recently called *V. aquatica*) were apparently quite distinct in this country, but they seemed to be very much less so in the Middle East.

With reference to Dr. Melville's remarks, it seemed quite possible that the oil-variants in *Eucalyptus* might be comparable to flower-colour variation in other plants. These were known to be under simple genetic control, single genes being responsible for the degree of oxidation or methylation of the pigments (cf. Scott-Moncrieff in Ergebn. Enzymforsch **8,** 28: 1939—quoted by Lawrence, Scott-Moncrieff and Sturgess in Journ. Genet. **38,** 303: 1939). The oils in the two varieties of *Cymbopogon* were certainly closely related (Fujita in Bot. Mag. Tokyo, **63,** 139: 1950).

In closing the discussion the PRESIDENT expressed the hope that the morphological designation might be retained for these biological races, even if it necessitated using a trinomial nomenclature.

PROCEEDINGS OF THE GENERAL MEETING ON
8 March 1951

Dr. W. E. SWINTON,
in the Chair.

The Proceedings of the General Meeting held on Thursday, 22 February 1951, having been circulated, were taken as read, and confirmed.

The following were thanked for gifts made to the Library since the last Meeting:—Mr. G. O. Allen, Mr. Christopher Sandeman, Mr. W. G. Wallace, the Indo-Pacific Fisheries Council, Bangkok, the Linnean Society of New South Wales, Sydney, and the School of Oriental and African Studies, University of London.

Mr. Derek Kellas, M.C. signed the Obligation in the Roll and Charter Book and was admitted a Fellow.

The proposed Alterations in the Bye-Laws, as printed in the report of the Meeting held on 22 February 1951, were read for the second time.

Certificates of recommendation in favour of following candidates for election to Fellowship were read for the first time:—Sidney Fay BLAKE, A.M., Ph.D., Alexis BOGDAN, John Leonard CLOUDSLEY-THOMPSON, M.A., Ph.D., Joseph George COCKBURN, M.Sc., Ph.D., Miss Winifred Mary CURTIS, M.Sc., Ph.D., Miss Sylvia Mavis DIXON, B.Sc., Jan Bevington GILLETT, M.A., Christopher Leighton HARE, M.Sc., Ph.D., Stanley John HUGHES, M.Sc., Ronald William John KEAY, M.A., B.Sc., Leonard Nixon KIDD, Edmund James KING, M.A., Norman Robert LEE, B.Sc., Rev. Professor R. LEPOUR, S.J., Ph.L., L.D., Miss Winifred May PAGE, M.Sc., Ph.D., Reginald Arthur PEACHEY, Anthony Brian Lowsley PEAKE, M.A., M.R.C.S.(Eng.), L.R.C.P. (Lond.), Miss Frances PITT, Peter Bernard PLATTS, Frederick John REED, Robert ROSS, M.A., Gilbert Westacott REYNOLDS, Robert Joseph Gay SAVAGE, B.Sc., George Herbert SEWELL, G. S. VERMA, M.Sc., Ph.D., John Thornton WILDASH, Mohammed Badi-uz-zaman ZAMAN, M.Sc.

The following communication was read and discussed:—

Prof. G. VANDEBROEK. New embryological data and the zoological position of the great groups of Metazoa. (Discussed by Dr. S. M. Manton, F.R.S.; Prof. Vandebroek replied.)

Abstract,—

Two general classifications of the Metazoa are mainly used: (i) the classification into Vertebrates and Invertebrates, (ii) the classification into Protostomes and Deuterostomes. Even if the first one is replaced by the subdivision into Chordates and Non-Chordates, both are illogical.

It is clear that in both classifications, there is one homogeneous group and one which is not homogeneous. Are the Chordates (or Vertebrates) and the Protostomes indeed homogeneous; while a lamprey, a starfish and a worm are all Invertebrates, as on the other hand a starfish and a bird are both Deuterostomes?

This classification problem can now be solved. Recent embryological studies show that:—

1. there are three different types of gastrulation and closure of the blastopore which correspond to, and are the expression of, three different organizations of the embryo:

   (*a*) the nototenic closure (by elongation of a dorsal blastoporal lip) of the Chordates;

   (*b*) the gastroraphic closure (by suture of two ventral blastoporal lips) of the Protostomes;

   (*c*) the isochilic closure (in which all the parts of the blastoporal margin have the same value) of the Echinoderms;

2. the Tunicates and Cephalochordates are typical Chordates;

3. the Enteropneusta are not at all related to the Chordates;

4. the Enteropneusta, Echinoderms and Chaetognatha may be grouped under the name of Cycloneuria;

5. there are relationships between Chordates and Protostomes which must have a common Coelenterate ancestor whereas the Cycloneuria must have arisen from a quite different group of Coelenterates.

Dr. S. M. MANTON: I have listened with much interest to Professor Vandebroek's address. Embryologists will welcome his new observations upon the Enteropneusta, and will look forward to a full account of this important work. However, the wider topics which he raised concerning general bases of classification and phylogeny can hardly be generally accepted. It must be remembered that among the invertebrate phyla in particular, a single group may show examples of the blastopore giving rise to both mouth and anus, to one or other, or to neither of these structures (Annelida and Arthropoda for example). The evidence quoted by Professor Vandebroek concerning Perpatus is based upon erroneous information, as shown by the 1949 account of the early development of several species of Onychophora ; in none of the these does the mesoderm arise from the lateral edges of the open blastopore, but from a primitive streak situated behind the blastopore. In some species there may be no blastopore. Then the living groups of Coelenterata are clearly ' modern ' and we know nothing of their ancestors. It is probable that the diploblastic ancestor of the triploblastic animals lacked a nematocyst, and our knowledge of such a primitive diploblast is nil. The embryology of modern Coelenterata cannot be regarded as a simpler or more primitive process than that of the several groups of triploblastic animals. The comparisons drawn by Professor Vandebroek between an erroneous account of Onychophoran development and the morphology of the most specialized of the modern coelenterates therefore carries no conviction, and the suggested evidence of affinity between the so called Protostomes and Chordates has little to commend it.

NEW AND RARE BRITISH SPIDERS

By A. F. Millidge and G. H. Locket.

(With 12 text figures.)

(Communicated by D. M. Reid, F.R.S.E., F.L.S.)

[Read 10 May 1951.]

We are recording and describing in this paper a number of spiders new to Britain, which we have collected or which have been sent to us by correspondents. Also included are notes on several species, a number of additions to county records, and the occurrence of some rare spiders.

(i) Spiders new to the British Isles.

The following additions to the British list have been captured :—

Zelotes petrensis (C. L. Koch) (females only).
Scotina palliardi (L. Koch) (both sexes).
Xysticus acerbus Thorell (males only).
Lycosa paludicola (Clerck) (authentic male recorded for the first time from Britain).
Araneus displicatus var. *westringi* (Thorell) (both sexes).
Lophocarenum radicicola (L. Koch) (male only).

Zelotes petrensis (C. L. Koch).

A female of this species was found running in bright sunshine at Abinger Common (Surrey) in April 1949 (A.F.M.). Two more females were found amongst moss and grass in the same place in September 1949, and another female under a stone in the same locality in May 1950. A female was found under a stone on Holmbury Hill (Surrey) in August 1950. A male has not yet been found. The species was identified by the figure given by A. Tullgren (1946, fig. 253), and by comparison with authentic specimens from the Koch Collection in the British Museum (Natural History).

Description: Female: length 6–6·5 mm. A typical *Zelotes* in general appearance, having the carapace, sternum and abdomen an almost uniform sooty black. The posterior eyes are nearly equal in size and almost equidistant. The legs are black, except for a yellow patch on the retrolateral side of femur I. The epigyne (fig. 1) is quite characteristic, but is rather similar to that of *Z. serotinus* L. Koch.

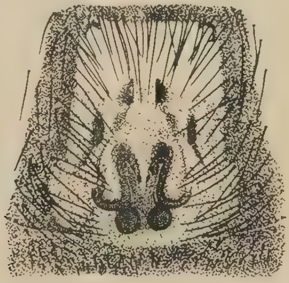

FIG. 1. *Zelotes petrensis.* Epigyne.

SCOTINA PALLIARDI (L. Koch).

A female of this species was found (A.F.M.) amongst moss and grass in Happy Valley, Boxhill (Surrey) in May 1949. Another female turned up in the same place in May 1950, together with several immature spiders probably belonging to this species.

In view of its close similarity to *S. gracilipes* (Bl.), a search was made amongst the specimens of the latter species in the Pickard-Cambridge Collection, in the Hope Department of the University Museum, Oxford, and in the Jackson Collection in the British Museum (Natural History), to find out whether any specimens of *S. palliardi* were present amongst these. There were none amongst Jackson's specimens, but in a tube of Pickard-Cambridge containing specimens collected at Bloxworth (Dorset) were three females and one male of *S. palliardi*. Both sexes have thus been taken in this country. They were identified by the excellent figures given by Tullgren (1946, figs. 108–111).

The other two species of the genus, *S. gracilipes* (Bl.) and *S. celans* (Bl.), are normally found in heather, being adult in August and September. The present species seems to frequent moss and grass, and is adult at an earlier period in the year.

It was suggested by E. Simon (1932, p. 973) and E. Reimoser (1937, p. 85) that *Agroeca diversa* Cambr. (O. Pickard-Cambridge, 1913, pp. 113 and 130, Pl. A, figs. 1–3) was a synonym of *S. palliardi*. Pickard-Cambridge's specimens have been examined, and they are actually *S. gracilipes* (Bl.).

Description: Length: female 3 mm., male 2·5 mm. The general coloration resembles *S. gracilipes*, although some specimens have the three light coloured longitudinal bands on the carapace clearly marked, much as in *S. celans*. The legs I and II have the patellae, tibiae and metatarsi considerably darkened, being almost black on the first pair; this darkening has not been noticed in *S. gracilipes*, but the coloration in both species may be subject to variation. The epigyne (fig. 2 *a*) is very similar to that of *S. gracilipes* (fig. 2 *b*), but the seminal ducts approach one another more closely than in the latter species. Fig. 2 (*b*) shows an epigyne in which the straight edges of the dark areas at either side are well developed; these straight edges are not always present, but when they are they provide a reliable character for distinguishing the females. The male palp (fig. 2, *c* and *d*) differs from that of *S. gracilipes* in the tibial apophysis, which is aculeate in S. *palliardi*, and in the form of the palpal organs. The latter resemble those of S. *celans* (fig. 2, *e* and *f*), but differ from that species in having the base of the stylus (S) much narrower, and in the disposition of the seminal coils (fig. 2, *c* and *e*).

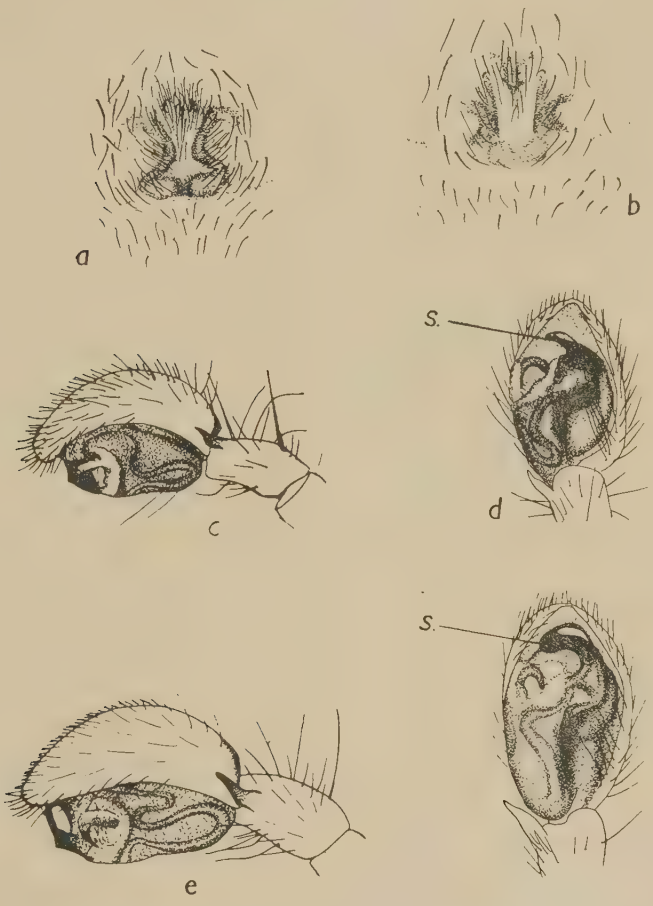

FIG. 2. *Scotina palliardi.* (*a*) Epigyne ; (*c*) male left palp from outside ; (*d*) ditto (from below). *Scotina gracilipes*, (*b*) Epigyne. *Scotina celans*, (*e*) male left palp (from outside) ; (*f*) ditto from below.

XYSTICUS ACERBUS Thorell.

A male of this species was found by Mr. A. M. Wild at Penrice (Glamorgan), South Wales, in 1948, running in short grass in a meadow. Another male was collected by the authors at Plaistow (Sussex) in grass on rough ground near a pond by the roadside, in early April 1950. The identity of this species was kindly confirmed by M. Jacques Denis, of Denain, France ; there were no specimens available in this country for comparison. The female has not yet been found here.

Description : Male : length 5 mm. The carapace has the sides brown, mottled and streaked with yellow ; the pale-yellow central area is almost filled by a blunt wedge-shaped mark which is brown, mottled with whitish yellow and dark brown blotches. There are a number of stout spines on the carapace and clypeus. The abdomen is dorsally dark brown, mottled with pale yellow, with a narrow white band around the front and sides, and with three or four ill-defined narrow yellowish-white transverse bars on the posterior half. The legs are whitish yellow, mottled and streaked with dark brown and reddish brown; the femora have longitudinal streaks of black dorsally and laterally. The palps are coloured like the legs. The palpal organs (fig. 3 (*a*)) have no apophyses, and the species falls thus into the same group as *X. luctuosus* (Bl.), *X. sabulosus* (Hahn), and *X. robustus* (Hahn). It quite clearly differs from these in being less deeply coloured, and in the form of the palpal organs; the palpal tibia, seen from the side (fig. 3 (*b*)) is quite characteristic.

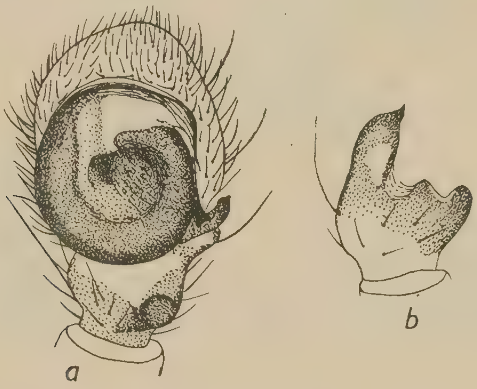

FIG. 3. *Xysticus acerbus.* (*a*) Left palp (from below); (*b*) right palpal tibia, from side.

LYCOSA PALUDICOLA (Clerck).

This species was recorded as British by O. Pickard-Cambridge (1902, p. 29, fig. 12), based on a female taken in 1900 by Rev. J. E. Hull in Parkhurst Forest (Isle of Wight). Two more females were collected by one of us (A.F.M.) in the same locality in May 1939, and their identification was confirmed by Dr. A. R. Jackson. The next appearance of this species was in 1948, when a female was sent for identification by Mr. A. M. Wild, who caught it near Plaistow, (Sussex), amongst grass on rough ground by the roadside. In May 1949, in the same locality, the authors found large numbers of females with egg-sacs, it apparently being too late for males. On 1 April 1950, a number of males were taken, and it was found that the species extended along the roadside, on the grass verges, for some distance. At this time, few females were visible and they were only just coming to maturity.

The species has been recorded by Hull (1948, p. 58) from Essex, but the figure he gave subsequently (Hull, 1950, Pl. III, fig. 10) for the male palp shows that the male, at least, was not *L. paludicola* (Clerck) but was probably *L. lugubris* (Walck.). Hence this record is open to doubt.

As the males collected at Plaistow are probably the first authentic males of *L. paludicola* (Clerck) to be taken in Britain, a description and figures are given here.

Description: Male: length about 7 mm. The carapace is very deep brown or black; the lateral light bands are continuous and have dentated edges. The median light band is dilated behind the eyes, then constricted, and, after widening again tapers towards its posterior end. The abdomen is dark brown, appearing black in living specimens. The sternum is dark brown to black, the light median band discernible in the female being here almost always absent or very faint. The legs are dark brown ; sometimes very faint annulations can be seen in preserved specimens. The palp (figs. 4*a* and *b*) is covered with black hairs. The spider has a characteristic dark colour when alive, and this with its size renders it distinguishable with tolerable certainty in the field from *L. amentata* (Clerck), whose markings are somewhat similar.

The male carries on a very definite courtship with the female. He starts by standing on tip-toe, the first pair of legs vibrating now and again. The palps are next raised, singly or together, forwards and upwards. They are then brought down to the ground sideways and finally returned to their normal position, so that one is reminded of the arm movements of a breast-stroke swimmer. These antics, as well as the occasional vibrations of the first two pairs of legs, are probably seen by the female, who was observed to be markedly affected by them, approaching the male in an obviously excited state. Copulation has not yet been observed.

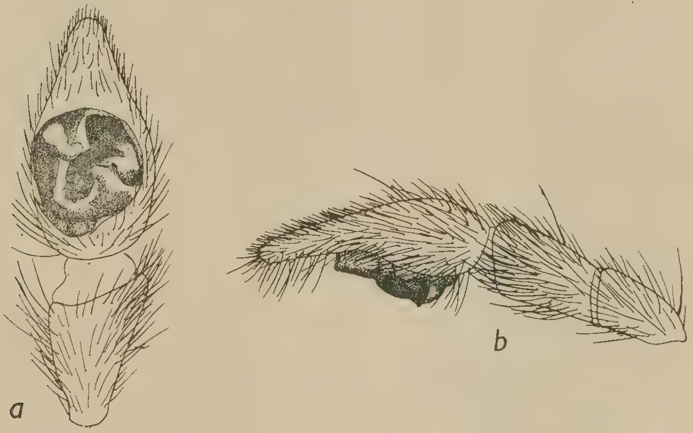

FIG. 4. *Lycosa paludicola.* Male left palp : (*a*) from below ; (*b*) from outside.

ARANEUS DISPLICATUS var. WESTRINGI (Thorell).

The first British record for this species was an immature male taken by Mr. N. A. Locket (from Mrs. G. H. Locket's hat !) on 14 April 1949 at Harrow, (Middlesex). This specimen reached maturity on 27 April ; and has been deposited in the British Museum. In April 1950, Mr. A. M. Wild sent for examination two immature females, obtained by beating pines in the grounds of Russell Hill School, Addington (Surrey). In May, three females were taken in the same place by Mr. Wild and one of us (A.F.M.) ; two were adult, and the third became adult a few days later. Mr. Wild subsequently obtained an adult male. Comparison of the males with a specimen taken by Dr. Bertkau at Bonn and now in the British Museum (Natural History), showed them to be *Araneus westringi* (Thorell). (Thorell, 1856, p. 166 and 1870, p. 547). Further comparison with specimens of *Araneus displicatus* (Hentz), kindly sent from the American Museum of Natural History by Dr. W. J. Gertsch, revealed a slight, but constant, difference from that species, shown in fig. 6 (*a* and *b*). These species have been regarded as synonymous (cf. Wiehle, 1931, p. 109), but since they must be referred to as separate forms, we propose to call *A. westringi* (Thorell) a variety of *A. displicatus* (Hentz), the latter having priority of name.

It is possible that *Epeira ornata* Bl. (Blackwall, 1861–4, p. 346) was this species, but the descriptions without figures are quite insufficient for definite identification.

In the following description, the coloration is given for living specimens; the abdominal colour fades in spirit to a uniform dull brown.

Description: length: female 5·5-6 mm., male about 4·5 mm. (Continental specimens seem to be larger; Wiehle (1931, p. 109) indicates about 11 mm. for the female, and a female in the British Museum (Natural History)—collected by Bertkau at Bonn—measures 8 mm.). The carapace is a reddish brown, the male sometimes having a pair of dark patches in the thoracic region. The abdomen (fig. 5 *a*: female) is slightly pointed in front. The darker parts of the pattern vary in colour from a bright brick-red to orange (the lateral part of the pattern, which in the specimen figured is confined to the posterior half, in another specimen ran the whole length of the abdomen). The median marks are surrounded by white borders and outside these is a green-yellow area. Along the outsides (and usually not visible from above) and extending

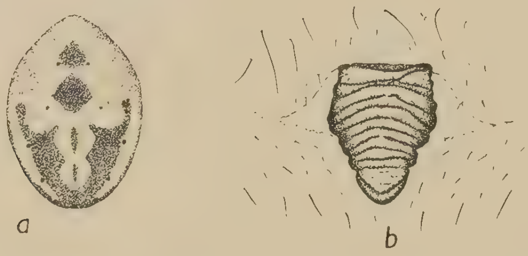

FIG. 5. *Araneus displicatus* var. *westringi*. (*a*) Abdomen; (*b*) Epigyne.

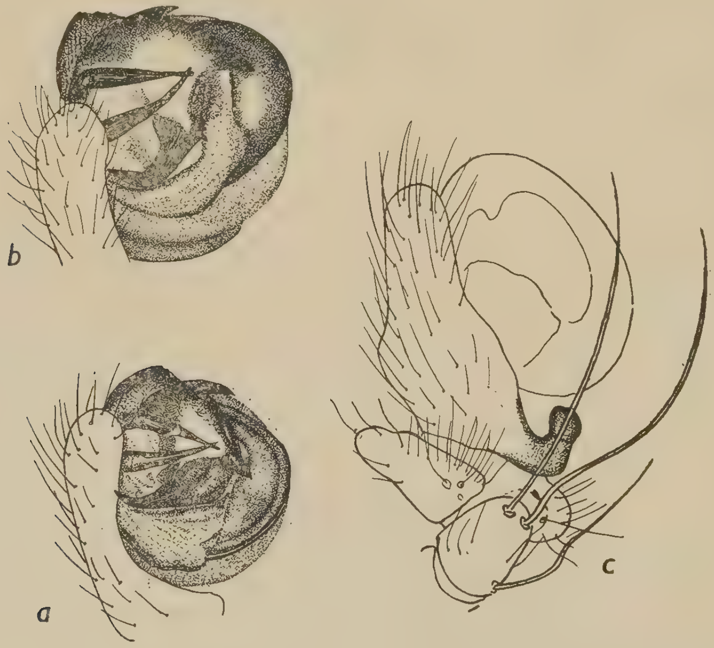

FIG. 6. (a) *Araneus displicatus* Hentz. Male left palp seen from below and a little to the outside. (*b*) *A. displicatus* var. *westringi*. Male palp viewed likewise: (c) right palp seen from above.

on to the ventral side, is a wide brick-red band running right round the abdomen ; it passes just above the spinners and is only broken at the extreme anterior end. There are three lateral pairs of rather large black spots on the posterior half and a fourth pair of smaller spots nearest the spinners (these may sometimes be absent ; one specimen had only one). Ventrally, a carmine or brown quadrilateral lies between the epigastric fold and the spinners, and on this are two pairs of green-yellow blotches (as in *A. alpicus*), sometimes fused to form a single yellow-green area. The quadrilateral is flanked by a pair of longitudinal yellow-green stripes, outside of which comes the wide brick-coloured lateral band. The male abdomen is similar, but lacks the four light blotches ventrally; instead there may be a single transverse green band immediately behind the epigastric fold. The sternum is brown (as the carapace), with (in the male) darker streaks running from between the coxae towards the centre. The legs of the female are coloured as the carapace, with faint darkening at the extremities of the segments ; in the male the general colour is the same, but the trochanters are black, the apices of the femora are slightly darker than the bases and the apices of the other segments are black. The epigyne (fig. 5 *b*) is quite distinct from those of the other species of the group. The male palp (fig. 6 *c*) has the paracymbium similar to those of *A. alpicus* and *A. inconspicuus* (fig. 8 *a* and *b*), but is disposed at a slightly different angle. The palp is most easily recognizable when seen from below and a little to the outside (fig. 6 *b*) ; it differs slightly but definitely from that of the American *A. displicatus* (Hentz) (fig. 6 *a*).

In the few specimens available the coloration varies, but the spiders are recognizable when alive, and the red or orange markings (which are very beautiful on the green field), are quite different from those of other species of this group. (The young of *A. cucurbitinus* are sometimes coloured similarly, but they always become green on reaching maturity).

ARANEUS CUCURBITINUS Clerck.

ARANEUS INCONSPICUUS (Simon.)

ARANEUS ALPICUS (L. Koch.)

ARANEUS DISPLICATUS var. WESTRINGI (Thorell.)

In view of the close resemblance of these four species, and of a certain amount of confusion in our literature, it seems desirable to put on record the distinguishing characters.

Males.

If the palps are viewed from below and a little from outside, a position not difficult to find as the spider normally holds them, the most useful differences are seen at once (figs. 6 and 7). *A. cucurbitinus* and *A. displicatus* var. *westringi* are distinct, and it remains to separate *A. alpicus* from *A. inconspicuus.* The falciform process '*r*' (which Kulczynski called the 'retinaculum') in *A. inconspicuus* can appear very like that in *A. cucurbitinus* var. *opistographus* Kulcz., but in fact its end is flat and truncated and not aculeate as in the latter species. In *A. alpicus* this process has a very distinct flat excrescence about halfway along its length (fig. 7 *a*), whereas in *A. inconspicuus* this is much reduced and in many positions not visible. A further distinction between these last two species lies in the shape of the small tubercle on the retrolateral apical margin of the coxae of the first pair of legs ; this points outwards in *A. inconspicuus* but is bent back in *A. alpicus* (fig. 9) (cf. Bosenberg, 1902, p. 31 ; Tab. I, fig. 14). The difference between *A. displicatus* and *A. displicatus* var. *westringi* is illustrated in fig. 6 (*a* and *b*). The paracymbium of *A. cucurbitinus* is characteristic (fig. 8 *c*), and the variety *opistographus* Kulcz. is distinguished from it by the shape of the process '*r*' in fig. 7 (*c* and *d*).

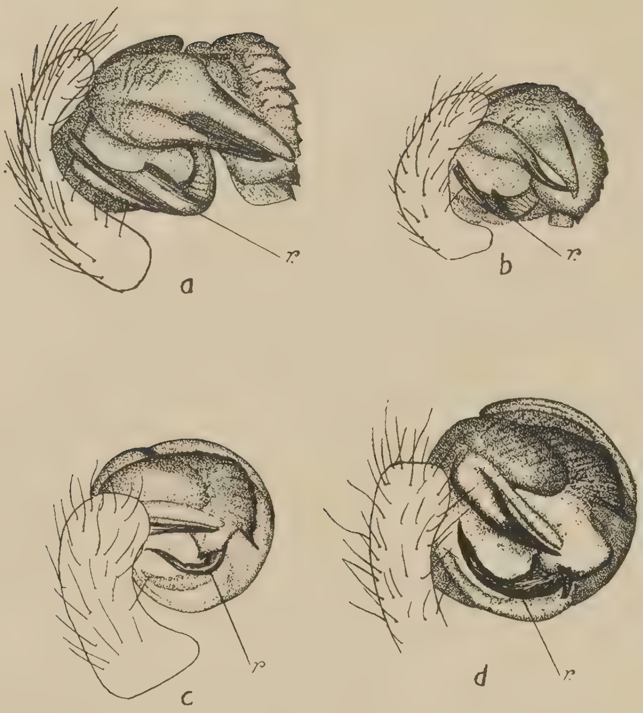

FIG. 7. Male left palp, seen from below and a little to one side: (a) *Araneus alpicus*; (b) *A. inconspicuus*. (c) *A. cucurbitinus*; (d) *A. cucurbitinus* var. *opistographus*. (r=retinaculum).

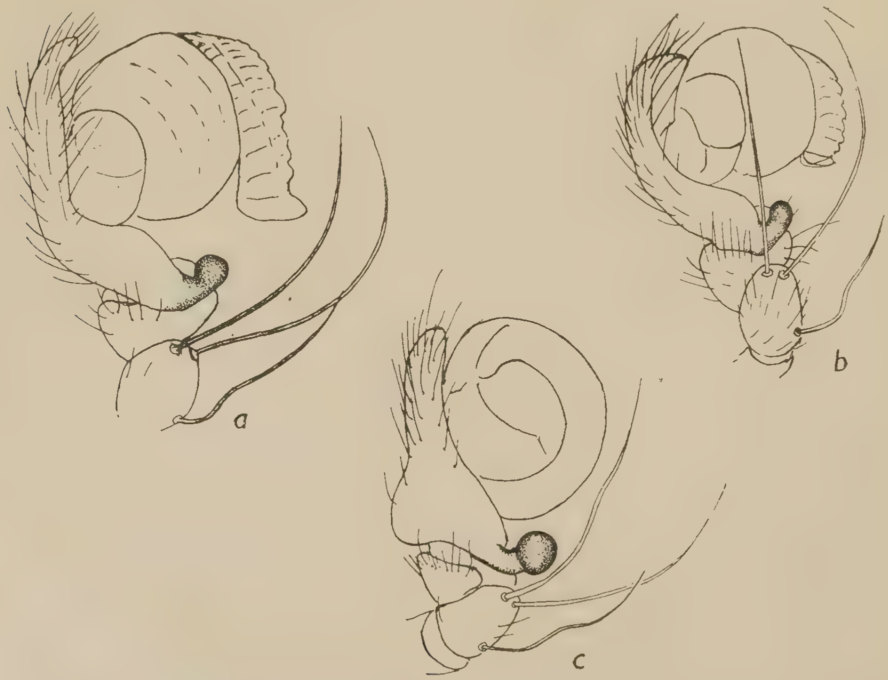

FIG. 8. Right male palp, seen from above. (a) *Araneus alpicus*; (b) *A. inconspicuus*; (c) *A. cucurbitinus*.

Females.

The epigynes of *A. alpicus* and *A. inconspicuus* are very similar (fig. 10) ; that of the former tends to be less constricted at its narrowest part, but the differences are very small and variation may be found to eliminate them. They are, on the other hand, quite different from the epigynes of *A. cucurbitinus* and *A. displicatus* var. *westringi*. Two other characters would seem to be reliable for distinguishing the two former species, viz. *A. alpicus* has on the ventral side of the abdomen two light green bands enclosing a dark green area on which are four rather large green-yellow patches set in a square. (Thorell, Wiehle and Kulczynski state that the anterior pair are sometimes fused). These patches are clearly visible in the field, and although coloration and other markings may fade on preservation in spirit, these are still quite clear on Jackson's specimen taken over twenty years ago, whereas they are absent in all the specimens of *A. inconspicuus* (some specimens of *A. cucurbitinus* have similar markings less well developed). A second distinction may be found in the proportions of the trapezium formed by the four median eyes. The ratio of the width of the front to that of the back is 0·95–1·09 in *A. alpicus* and 1·15–1·3 in *A. inconspicuus* (measurements being taken from the outside edges of the eyes). Finally the distance between the anterior median eyes is 0·13–0·17 mm. in *A. alpicus* and 0·185–0·19 mm. in *A. inconspicuus*. These measurements have always hitherto been in correspondence with the presence or absence of the four yellow patches mentioned above. Kulczynski (1905, p. 248) considered that occasions may arise when the eye measurements are the only distinguishing factors.

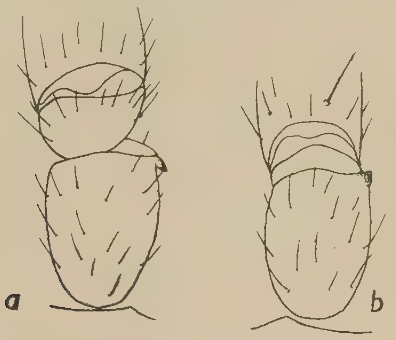

FIG. 9. Male coxa I, seen from below ; (a) *Araneus alpicus*, (b) *A. inconspicuus*.

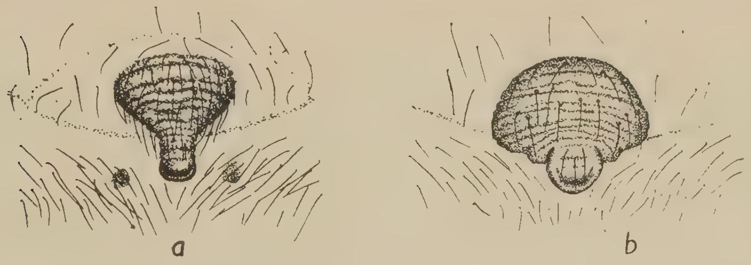

FIG. 10. Epigyne. (a) *Araneus alpicus* and *inconspicuus* ; (b) *A. cucurbitinus*.

A word should be said about the black spots on the dorsal side of the abdomen, since there appears to have been some confusion here, and there is certainly some variation in these among specimens of the same species. From fig. 11 it will be seen that four spots always form a quadrilateral in the middle or fore half and that these are sometimes followed by another pair. In addition to these median spots there is a variable number of black marginal spots on the posterior half of the abdomen: these we shall now consider. (The relative sizes of the abdomen as depicted are not significant, as they vary enormously with the condition of the eggs). In *A. cucurbitinus* there are up to five pairs of marginal spots on the posterior half. Two pairs of these are present in Jackson's specimen of *A. alpicus*, but in a specimen captured on Box Hill, Surrey, in May 1946, none was visible; Wiehle (1931, p. 110) mentions 0–3 pairs. In *A. inconspicuus*, although one pair of smaller spots always seems to occur behind the main median quadrilateral, these are in a median position and quite distinct from the more lateral rows occurring in the other species. So that when Wiehle (1931, p. 112) says 'Auf der hinteren Hälfte des Abd. fehlen die schwarzen Punkte immer vollständig', it appears that he is referring to these lateral rows, especially in view of his use of them in his key. It is clear that Jackson (1933, p. 282) supposed that Wiehle had meant to indicate that black spots should be missing from the abdomen altogether in this species.

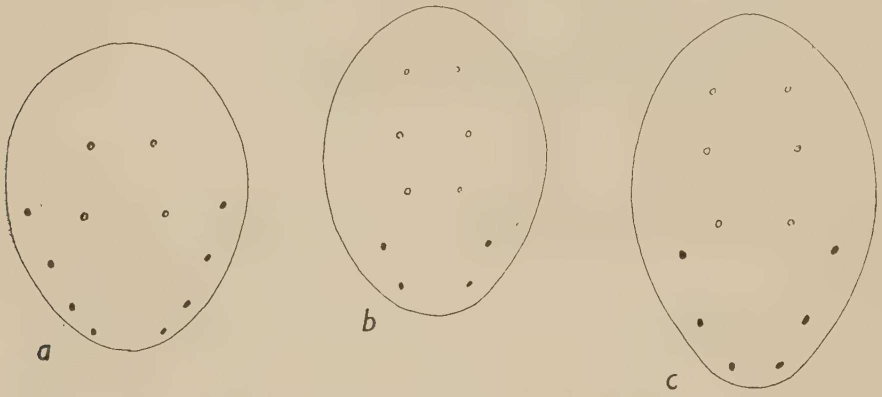

FIG. 11. Abdomen. (a) *Araneus cucurbitinus*; (b) *A. alpicus*; (c) *A. westringi*.

In both *A. alpicus* and *A. inconspicuus* there is a roseate marking on the dorsal side of the spinners. In the reared females of the latter species two bands of similar colour ran from the spinners round the ventral side of the abdomen to just in front of the branchial opercula, but they faded as the animals fed and became distended. In both species the legs and carapace are reddish brown, without markings, except that some males of *A. inconspicuus* have been found with wide black borders to the carapace (as in *A. cucurbitinus*).

Whether *A. alpicus* should be regarded as a separate species from *A. inconspicuus* or merely as a variety of it must remain in some doubt until breeding experiments can be carried out. Wiehle (1931, p. 112) thinks it is on the borderline between the two. It does appear, however, that the differences in both sexes are considerable (far greater for instance than in the two varieties of *A. cucurbitinus*) and that they run true. As *A. alpicus* is recognized on the continent as a separate species, we propose to follow suit and keep it as such on the British list.

RECORDS of *A. inconspicuus* (Simon) and *A. alpicus* (L. Koch).

Both sexes of *A. inconspicuus* have been collected again in recent years, in the New Forest by Mr. A. A. D. La Touche (1944, male only) (1946, p. 288), and by the authors at Leckford (Hants.) (April 1946, both sexes), near Beaulieu River (Hants.) (September 1949, female, immature and subsequently reared), Great Kimble (Bucks.) (April 1948, 1949 and 1950), Box Hill (April 1949 and 1950), Ranmore Common (April 1950), Holmbury Hill (May 1950), and Addington (May 1950), all Surrey, and Ruislip Common (Middlesex) (Sept. 1949, female, immature and subsequently reared). Two females and a male were reared from a batch of eggs laid by one of the Leckford specimens, thus establishing beyond question the identity of the female. The only earlier record is by Pickard-Cambridge, who received a male (' with a female ', which appears to have been lost) from Glanvilles Wootton (Dorset) in June 1877. This is called *Epeira westringi* in *The Spiders of Dorset* (pp. 260, 261), but Pickard-Cambridge (1906, p. 79) renamed it *Aranea inconspicua* Sim. after reading Kulczynski's description (1905). It is beyond doubt identical with the males which are now recorded ; its palp has now become bleached, but the parts are still quite clear. Pickard-Cambridge (1913, p. 123) recorded a male spider captured at Wytham (Berkshire) in 1912 as *Epeira westringi* Thorell, but Jackson (1933, p. 282) considered this to be nothing more than *A. cucurbitinus* var. *opistographus* and a further examination of the specimen has entirely confirmed this view.

A. inconspicuus is less rare than was previously supposed, probably because it was not searched for early enough in the year, viz. April and early May. It is most frequent in evergreens, and it is interesting to note that the young are green in colour as soon as they emerge from the cocoon (unlike *A. cucurbitinus* in which they are variable, but unusually reddish-brown until the leaves are on the trees in May). Being mature in April they must have wintered sub-adult, and so might be conspicuous on deciduous trees ; nevertheless we have twice found them by beating oaks. Wiehle (1931, p. 113) quotes Bertkau as saying that the species reaches maturity at the end of April or beginning of May ; this agrees with our observations in this country.

Only one female and one male of *A. alpicus* remain in the Jackson collection, although he recorded (1932, p. 211) captures by Dr. Haines in the New Forest from 1923 to 1927. Mr. A. A. D. La Touche recorded (1946, p. 288) the capture of two males in the New Forest, and he has discovered what seemed to be another male taken in 1944 or 1945. After further examination, however, he agrees with us that only one of these males is *A. alpicus*, the other two being *A. inconspicuus*. The female in the Jackson Collection is entirely typical according to all available descriptions. Two more females have since been taken (by G. H. L.) ; one from Box Hill is typical in the arrangement of the median eyes and in having four light patches on the ventral side of the abdomen, but lacks the posterior lateral spots on the dorsal side. The other specimen, from Great Kimble (Bucks.) is also typical, except that it has only one spot on one side of the posterior end of the abdomen. Both were found in close proximity to *A. inconspicuus*.

Chamberlin and Ivie (1942, p. 76) have proposed a new genus ' *Araniella* ' for the spiders of this little group, the grounds given being : ' The abdomen is rounded, and typically bears a series of spots along each side of the dorsum. The male has a small spur at the distal end of coxa I, and a spur on the anterior ectal margin of the endites. The median apophysis of the palps is a simple, single-pointed process '. If the ' spots along each side of the dorsum ' refers to the median spots, they are present in many Aranei, but if to those outside on the posterior half of the abdomen, they are absent in *A. inconspicuus*. As to the spurs on coxae I, they are typical of the genus *Araneus*, and the shape of the median apophysis of the palp is extremely variable throughout the genus. The absence of specialized spines on the prolateral sides of tibiae II in the males might have been quoted, but as these are variable within the genus *Araneus* and also occur outside it (e.g. in *Cercidia* and *Singa*) they do not, in our view, carry much weight. These species are obviously closely allied, but they are in our opinion very typical *Aranei.*

Lophocarenum radicicola (L. Koch).

A male *Lophocarenum* was received from Mr. A. D. Blest, who collected it at Heyshott (Sussex) in June 1949. It was identified as *L. radicicola* (L. Koch), and this was kindly confirmed by M. Jacques Denis. Whether this is a truly established species, or merely an aeronaut from the Continent, remains to be discovered.*

Description : Male : length 1·3 mm. The carapace is brown with blackish fovea and striae. The head is raised (as in other species of the genus) into a lobe, compressed and hollowed at the sides (fig. 12*a*) ; this lobe, seen from above (fig. 12*b*) is almost twice as broad as long, and differs from the other British species of *Lophocarenum* in being divided by a central longitudinal furrow, very clear when seen from in front (fig. 12*c*). The lobe, which carries the posterior median eyes, is suffused with black. The *abdomen* is grey with dorsally a brown scutum which bears four faint impressed dots. The legs are pale brownish yellow. The sternum is yellow, suffused with black, particularly at the edges. The palp has the tibia (fig. 12*d*) produced apically into two apophyses ; the palpal organs are shown in fig. 12*e*. This little spider is quite distinct from the remaining British species of *Lophocarenum*.

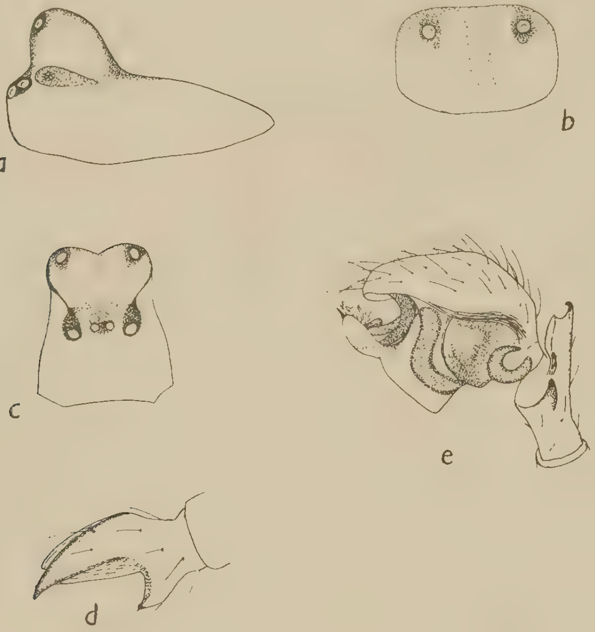

FIG. 12. *Lophocarenum radicicola* (male). (*a*) Carapace, from side ; (*b*) Cephalic lobe, from above ; (*c*) ditto, from in front ; (*d*) left palpal tibia, from above ; (*e*) left palp, from side.

(ii) Notes on Some Spiders.

OXYPTILA BREVIPES (Hahn)=*O. flexa* Cambridge. European specimens of *O. brevipes* (Hahn) from the Koch Collection in the British Museum (Natural

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* Females have since (Sept. 1951) been found (A.D.B.) and the species seems to be established.

History) have been compared with British specimens of *O. flexa* Cambridge, and the two species found to be identical. The correct name is therefore *O. brevipes*, which has priority.

LYCOSA TARSALIS var. HERBIGRADA Bl. There seems to be no doubt that *Lycosa herbigrada* Bl. is a variety of *L. tarsalis* Thor. We have collected specimens intermediate between the two forms, in regard to both carapace and abdomen patterns (cf. G. H. Carpenter, 1898, p. 201, figs. 5–9). The extreme forms interbreed freely and produce fertile eggs and young ; a second generation has not yet been reared from these.

LYCOSA PULLATA (Clk.) and L. PRATIVAGA L. Koch. These species will mate with one another in captivity. In two cases young were hatched within the cocoons, but they did not emerge and were abandoned by the mothers. It may well be that specimens occasionally met with, intermediate in markings, arise from a natural crossing. It is hoped to continue an investigation of this point.

ARANEUS MARMOREUS Clk. Until recent years this species was known to be represented in Britain only by the variety *pyramidatus* Clk. In April 1948 two females of the true species were received for identification from Mr. F. Dixon, of York ; they were taken the previous autumn at Acomb (Yorkshire). Subsequently Mr. Dixon sent more females and males, several specimens being intermediate in pattern between *marmoreus* and *pyramidatus*. The species was also found on Strensall and Skipworth Commons (Yorkshire). The two varieties occur together in these localities. The sexual organs of the two varieties are indistinguishable, but the abdominal patterns are very distinct.

POCADICNEMIS PUMILA (Bl.)=*Meioneta impavida* Hull. The type female of *Meioneta impavida* Hull (1950, p. 422) has been examined through the good offices of Mr. Murgatroyd. It is in fact *P. pumila* (Bl.).

BATHYPHANTES GRACILIS (Bl.)=*Oreodia minutula* Hull. The type female of *Oreodia minutula* Hull (1950, p. 420) has been examined, also through the kindness of Mr. Murgatroyd. It is in fact *B. gracilis* (Bl.).

PORRHOMMA OBLITUM (Cambr.)=*P. oblongum* (Cambr.). Comparison of the females of these two species, from the Pickard-Cambridge Collection in the Hope Department, University Museum, Oxford, indicates that they are identical. The cleared vulvae show no difference. No male of *P. oblongum* is available. *P. oblitum* has priority of name.

CENTROMERUS BICOLOR CONCINNUS (Thor.)=*Troglohyphantes margerisoni* Falconer. The type female of *Troglohyphantes margerisoni* Falc. (Falconer, 1919, p. 297, figs. 1–2) has been examined by the courtesy of Mr. W. K. Ford, of the City of Liverpool Public Museum. It is *C. bicolor concinnus* (Thor.). The specimen is somewhat abnormally pigmented around the eyes (which do not appear to be fully developed) but is otherwise quite typical. It is a common species in the north of England.

(iii) OCCURRENCE OF SOME RARE SPIDERS AND ADDITIONS TO COUNTY RECORDS.

New county records are marked with an asterisk (*), and the County is printed in italics. A number of these records are based on material sent for identification by other collectors, whose initials are appended to the record ; these collectors names and initials are as follows :—

Mr. A. D. Blest, Tonbridge (A.D.B.) ; Dr. J. L. Cloudsley-Thompson, Cambridge (J.L.C.-T.) ; Mr. Bruce Forman, Aberdeen (B.F.) ; Miss M. Hazelton, Berkhamsted (M.H.) ; Mr. M. C. D. La Touche, Harrow (M.C.D.LaT.);

Mr. J. H. Murgatroyd, Bournemouth (J.H.M.) ; Sir Arthur Pickard-Cambridge (A.P.-C.) ; Dr. R. Richter, Gordonstown (R.R.) ; Mr. G. W. Whatmough, Lincoln (G.W.W.) ; and Mr. A. M. Wild, South Croydon (A.M.W.).

Atypus affinis Eich. Boxhill (Surrey) ; in chalk in Happy Valley, Sept. 1949 and May 1950 and a wandering male in May 1951.

**Dictyna latens* (Fabr.). Near Bredon Hill (*Worcs.*), May 1947.

**D. uncinata* Thor. Males from Fletwick (*Beds.*) (J.L.C.-T.).

Argenna subnigra (Cambr.). This uncommon species has turned up on several occasions in recent years in the Isle of Wight, on sandhills, under stones and amongst grass.

**Ciniflo similis* Bl. *Aberdeenshire* (B.F.).

Uloborus walckenaerius Latr. Immature specimens on heather at Crookham (Hants.), Oct. 1949.

Hyptiotes paradoxus (C. L. Koch.) Boxhill (Surrey) ; a flourishing colony with several webs visible ; adults in Aug.

**Oonops domesticus* de Dalmas. In a house at Coventry (*Warw.*) ; Aug. 1947.

**Drassodes pubescens* (Thor.). Not uncommon amongst grass and moss on Park Downs (Surrey) and Happy Valley, Box Hill (Surrey) ; Adults in May and June. Ham Street (*Kent*), June 1950 (A.M.W.).

D. silvestris (Bl.). Males. Matfield (Kent) Sept. 1946 and Ham Street (Kent), June 1950 (A.M.W.).

**Phaeocedus braccatus* (L. Koch). Immature specimens in Happy Valley, Boxhill (*Surrey*), under stones and in grass and moss, Sept. 1949 and Spring 1950 ; adult female in June 1950.

**Zelotes petrensis* (C. L. Koch). Abinger Common (*Surrey*) and Holmbury Hill (Surrey) ; see above.

**Z. praeficus* (L. Koch). Happy Valley, Box Hill (*Surrey*) ; males and females, in May, June and July.

**Z. lutetianus* (L. Koch). Immature specimens in profusion on seashore, between tide marks, under stones and seaweed, Brighstone Bay (*I. of Wight*), Aug. 1949 ; female became adult in captivity in March 1950. Both sexes in Wicken Fen (Cambridgeshire), June 1947.

**Z. pusillus* (C. L. Koch). A female at Blackgang (*I. of Wight*), June 1946.

**Gnaphosa lugubris* (C. L. Koch). Two adult females, Aug. 1948 and 1949, with numerous immature specimens, on low cliffs and on seashore, Brighstone Bay (*I. of Wight*).

**Clubiona coerulescens* L. Koch. A male beaten from young oaks, near the ground, Ruislip Common (*Middlesex*), May 1949.

**C. diversa* Cambr. Both sexes, on dead branches under trees, Lake Vyrnwy (*Montgom.*), April 1950.

**C. neglecta* Cambr. *Aberdeenshire* (B.F.).

**Agroeca proxima* (Cambr.). *Morayshire* (R.R.).

**Agraecina striata* (Kulcz.). Wicken Fen (*Cambridgeshire*) ; 9 females and a male from cut sedge at the far end of the Drove, June 1946 and 1947. New to the Fen.

**Scotina palliardi* (L. Koch). Happy Valley (*Surrey*) and Bloxworth (*Dorset*) ; see above.

**S. celans* (Bl.). A pair from the *Isle of Wight* (A.M.W.).

**Phrurolithus minimus* C. L. Koch. Ham Street (*Kent*), a female (A.M.W.) ; a very rare species.

Zora armillata Sim. Numerous in Wicken Fen (Cambridgeshire), June 1946 and 1947.

Z. spinimana (Sund.). This species was found in Chippenham Fen (Cambridgeshire), and *Z. armillata* was not taken.

Xysticus ulmi (Hahn). Wicken Fen ; males and females, the latter spun up with their egg-cocoons on *Phragmites* in June. A male from Plaistow (Sussex), May 1950.

X. bifasciatus C. L. Koch. Appears to be fairly common amongst moss and grass on the North Downs in Surrey.

**X. acerbus* Thor. *Glamorgan* (S. Wales) ; Plaistow (*Sussex*) ; see above.

**Oxyptila trux* (Bl.). A female, near Coventry (*Warw.*) ; Lake Vyrnwy (*Montgom*), April 1950.

O. nigrita (Thor.). A female of this rare species amongst grass on Park Down, Chipstead (Surrey), May 1948. A male at Blackgang (Isle of Wight), June 1946.

**O. simplex* (Cambr.). A male from Tonbridge (*Kent*) (A.D.B.).

**O. atomaria* (Panz.). *Morayshire* (R.R.).

**Salticus scenicus* (Clk.). *Morayshire* (R.R.).

**S. zebraneus* (C. L. Koch). A male, on a post near Plaistow (*Sussex*), May 1948 (A.M.W.). Another male in the same vicinity, May 1949, by the authors. A very rare species.

Marpissa pomatia (Walck.). Still common in Wicken Fen, June 1946 and 1947.

**Bianor aenescens* (Sim.). Appears to be common in several places in Surrey ; Park Downs, Chipstead, and Leith Hill. Adult males in May and June, females all the summer. Ham Street (*Kent*), a female, June 1950 (A.M.W.).

Neon valentulus Falconer. Wicken Fen, June 1946 and 1947. A pair in Chippenham Fen (Cambridgeshire), June 1947 ; previously known only from Wicken Fen.

**Euophrys petrensis* (C. L. Koch). A male on heather, Walton Heath (*Surrey*), May 1948.

**Myrmarachne formicaria* (Degeer). Parkhurst Forest (Isle of Wight), June 1946. On sandhills, in marram grass, Yarmouth (I. of Wight), Aug. 1949. On a salt marsh by Beaulieu River (Hants.), Sept. 1949. A colony near Ryarsh (*Kent*) (A.D.B.).

**Lycosa arenicola* Cambr. On shingle at Ardmore, near Clifden (*Co. Galway*), Sept. 1946 ; young and some mature females. A male reared in captivity. This is the first record for Eire.

**L. agrestis* Westr. Large numbers in Arlesey chalk pit (*Bedfordshire*) near Letchworth ; the varieties *pseudoagricola* Dahl and *pseudomonticola* (Sim.) were also present.

L. purbeckensis (F. Cambr.). A specimen collected near Clifden (Co. Galway) on peat moors about a mile from the sea shore (where it was frequent). Not usually found far from the sea shore.

L. rubrofasciata (Ohl.). Females and young, Wicken Fen, June 1946 and 1947.

Trochosa fulvolineata (Lucas). Another female of this rare species was taken on a salt marsh by Beaulieu River (Hants.), Sept. 1949. Previously found in Hants. by Mr. A. A. D. La Touche on Lymington Saltings.

T. spinipalpis (F. Cambr.). Several females, Wicken Fen, June 1947.

**L. paludicola* (Clk.). Plaistow (*Sussex*) ; see above.

**Xerolycosa miniata* (C. L. Koch). Males and females on sand dunes, St. Helens (*Isle of Wight*), June 1946.

**Arctosa cinerea* (Fabr.). A female, on shingle bank of River Ystwyth, Llanafan (*Card.*), Aug. 1949 (J.L.C-T.).

**Pisaura mirabilis* (Clk.). *Aberdeenshire* (B.F.).

**Tegenaria silvestris* L. Koch. A female in an ice-house, Berkhamsted (*Herts.*) (M.H.).

**Hahnia nava* (Bl.). In moss and grass in various localities in *Surrey.*

**H. helveola* Sim. *Aberdeenshire* (B.F.).

***Tetragnatha pinicola* L. Koch. A male from Marley near Haslemere (*Surrey*) (A.P.-C.).

Araneus patagiatus Clk. A male on oak, Ruislip Common (Middlesex), 13 Sept. 1949. This seems to be a fairly rare species and its season to be long; a female was taken in the same locality on 22 June 1936.

**A. triguttatus* (Fabr.). Stanmore (*Middlesex*), May 1947 (M.C.D.LaT.). A variety with a bright yellow patch was taken on Box Hill in April 1950.

**A. redii* (Scop.). Females near Bredon Hill (*Worcs.*), May 1947. Both sexes adult, March 1948, at Headley Heath (Surrey).

**A. inconspicuus* (Sim.). *Surrey*, *Bucks.* and *Middlesex*; see above.

**A. displicatus* var. *westringi* (Thor.). *Middlesex* and *Surrey*; see above.

**A. angulatus* Clk. Immature specimens, Plaistow (*Sussex*) (A.M.W.).

**A. marmoreus* Clk. *Yorkshire*; see above.

Zilla diodia (Walck.). Both sexes near Plaistow (Sussex), May 1949 and 1950.

**Zygiella x-notata* (Clk.). *Aberdeenshire* (B.F.).

**Singa hamata* (Clk.). An immature male from Crathie (*Aberdeenshire*), Aug. 1948; this appears to be the only record for Scotland.

**S. pygmaea* (Sund.). A male and female, Marley, near Haslemere (*Surrey*) (A.P.-C.). Both sexes from Park Downs, Chipstead (Surrey), May–June 1948. Both sexes on sandhills at Yarmouth (*Isle of Wight*). A female from Fletwick (*Beds.*) (J.L.C-T.). Both sexes from *Morayshire* and *Nairn* (R.R.).

S. albovittata (Westr.). Females of this pretty little species on Park Downs, Chipstead (Surrey), amongst grass, May–June 1948.

**Meta bourneti* Sim. Established in a shallow air-raid shelter, erected in 1942, at Rendcomb College (*Glos.*), at least 100 yds. from a conduit for pipes where it was seen previously by members of the College. Eight specimens were taken (including an adult female and two young males) in April 1947. The only previous record was by Browning and Tams (1944, p. 95) at Gedding (Suffolk).

**Theridiosoma gemmosum* (L. Koch). Frensham Common (*Surrey*), where a colony was found (A.D.B.).

**Episinus angulatus* (Bl.). Females in Parkhurst Forest (*Isle of Wight*), June 1946, and a male at Yarmouth (I. of Wight), on sandhills, June 1946. Female at Wicken Fen (Cambridgeshire), June 1946.

**Theridion sisyphium* (Clk.). A male from Fletwick (*Beds.*) (J.L.C-T.).

**T. impressum* L. Koch. A female from Marley, near Haslemere (*Surrey*) (A.P.-C.).

**T. denticulatum* (Walck.). A male, Lake Vyrnwy (*Montgom.*), April 1950.

**Lithyphantes albomaculatus* (Degeer). A female at Oxshott (*Surrey*), May 1946. Also from Frensham (Surrey) (A.D.B.).

**Dipoena prona* (Menge). A male of this very rare species from Tonbridge (*Kent*) (A.D.B.).

**Steatoda bipunctata* (Linn.). *Aberdeenshire* (B.F.).

Crustulina sticta (Cambr.). Both sexes frequent in Wicken Fen, June 1946 and 1947.

Pholcomma gibbum (Westr.). Both sexes, Wicken Fen, June 1946 and 1947; new to the Fen.

**Nesticus cellulanus* (Clk.). *Aberdeenshire* (B.F.).

**Ero cambridgei* Kulcz. A male from Happy Valley, Box Hill (*Surrey*), March 1950.

**Ceratinella brevis* (Wid.). Both sexes, Lake Vyrnwy (*Montgom.*)

**C. brevipes* (Westr.). Tonbridge (*Kent*) (A.D.B.). *Morayshire* (R.R.). Lake Vyrnwy (*Montgom.*).

**C. scabrosa* (Cambr.). A female, Wicken Fen (*Cambridgeshire*), June 1946; an infrequent species, new to the Fen.

**Blaniargus herbigradus* (Bl.). Both sexes, Lake Vyrnwy (*Montgom.*).

B. laudatus (Cambr.). Fairly common under stones at Blackgang (Isle of Wight), Aug. 1948 and 1949; generally uncommon.

Anacotyle stativa (Sim.). Four males of this rare species from Tonbridge (Kent) in 1949 (A.D.B.).

**Metopobactrus prominulus* (Cambr.). Both sexes, Parkhurst Forest and near Shorwell (*Isle of Wight*), June 1946 and July 1948 resp. Common in grass and moss in Happy Valley, Box Hill (*Surrey*), in spring and summer.

Trichopterna thorelli (Westr.). Frequent amongst grass and moss on Park Downs, Chipstead (Surrey), and Box Hill (Surrey); usually regarded as uncommon.

**T. mengei* (Sim.). A male on Lochnagar (*Aberdeenshire*), Aug. 1948; a male at Lake Vyrnwy (*Montgom.*), April 1950.

Entelecara omissa Cambr. Still common at Wicken Fen, June 1946 and 1947.

**E. flavipes* (Bl.). Males from near Tonbridge (*Kent*) (A.D.B.) in 1949.

**E. erythropus* (Westr.). Crackley Wood, nr. Coventry (*Warw.*) in 1946.

**Caledonia evansi* Cambr. A female, *Stirlingshire* (A.D.B.).

**Cnephalocotes* (*Nematogmus*) *obscurus* (Bl.). Lake Vyrnwy (*Montgom.*).

**Silometopus curtus* (Sim.). Both sexes at Clifden (*Co. Galway*), Aug.–Sept. 1946.

**S. interjectus* (Cambr.). From clinker of filter beds in sewage farm, Tonbridge (Kent) (A.D.B.), 1949. A male in straw, near Rendcomb (*Glos.*), April 1947. A female in a garden at Coulsdon (*Surrey*), May 1950—possibly brought in in straw.

**Lophocarenum nemorale* (Bl.). A male from Goatchurch Cavern (*Somerset*) (M.H.).

**L. parallelum* (Wid.). *Isle of Wight*, 1940 and 1946.

**L. radicicola* L. Koch. Heyshott (*Sussex*); see above.

**Minyriolus pusillus* (Wid.). A male near Coventry (*Warw.*), April 1947.

**Tiso vagans* (Bl.). A male, Lake Vyrnwy (*Montgom.*), April 1950.

**Diplocephalus latifrons* (Cambr.). Both sexes, Lake Vyrnwy (*Montgom.*).

**D. picinus* (Bl.). A female, Leet Valley (*Flint*), June 1949 (J.H.M.).

**Savignia frontata* Bl. Females, Lake Vyrnwy (*Montgom.*), April 1950.

**Erigonella hiemalis* (Bl.). *Erigonella* (Dahl, 1901) now seems to be the correct genus for this species and *ignobilis* (Cambr.). Amongst moss and grass, Abinger Common (*Surrey*) and nearby, throughout the year. Both sexes, Lake Vyrnwy (*Montgom.*), April 1950.

**Monocephalus fuscipes* (Bl.). Abundant at Lake Vyrnwy (*Montgom.*); *Aberdeenshire* (B.F.).

**Thyreosthenius biovatus* (Cambr.). A female, *Stirlingshire* (A.D.B.). Both sexes, *Morayshire* (R.R.).

Minyrioloides trifrons (Cambr.). Still common at Wicken Fen, June 1946 and 1947. This species is not an *Entelecara*, but belongs in the genus *Minyrioloides* (Holm, 1945, p. 31).

**Tapinocyba praecox* (Cambr.). A female, Stanmore (*Middlesex*), May 1946 (M.C.D.LaT.). A male near Leith Hill (Surrey) in moss, Dec. 1949.

**Colobocyba mitis* (Cambr.). A female of this exceedingly rare species at Kingsley Green (*Surrey/Sussex* border), April 1949 (A.D.B.).

**Walckenaera acuminata* Bl. A female, Lake Vyrnwy (*Montgom.*), April 1950.

Wideria melanocephala (Cambr.). Two males at Wicken Fen, June 1946. A female at Chippenham Fen, June 1947.

**W. fugax* (Cambr.). A male from Tonbridge (*Kent*), 1949 (A.D.B.). A male in pine-needles, Leith Hill (*Surrey*), Feb. 1950. An uncommon species.

**W. capito* (Westr.). A female at Tonbridge (*Kent*), Feb. 1949 (A.D.B.); usually found in this country at or near the tops of mountains, and only once previously recorded (we believe) from the south of the country.

**W. nodosa* (Cambr.). A female in moss, Leith Hill (*Surrey*), Feb. 1950.

**Trachynella nudipalpis* (Westr.). Lake Vyrnwy (*Montgom.*), April 1950.

**T. obtusa* (Bl.). A female of this rare species, in the Leet Valley (*Flint*), June 1949 (J.H.M.).

**Tigellinus furcillatus* (Menge). Both sexes amongst grass and heather in Parkhurst Forest (*Isle of Wight*), June 1946. A male in moss and grass in Happy Valley, Box Hill (Surrey), May 1950.

**Cornicularia cuspidata* (Bl.). A female on Conach Craig (*Aberdeenshire*), Aug. 1948.

C. vigilax (Bl.). Both sexes in Wicken Fen, June 1946 and 1947; a rare species still.

**Trichoncus saxicolus* (Cambr.). A male from Park Downs, Chipstead (*Surrey*), May 1948. A male from Ryarsh (*Kent*), May 1948 (A.D.B.). Both sexes amongst moss and grass in Happy Valley, Box Hill in Spring 1950.

**Dismodicus bifrons* (Bl.). A male, Lake Vyrnwy (*Montgom.*), April 1950.

**Erigone arctica* (White). Both sexes amongst seaweed, Clifden (*Co. Galway*), Sept. 1946, and Chale Bay (*Isle of Wight*), Aug. 1949.

**E. dentipalpis* (Wid.). A pair, Fletwick (*Beds.*) (J.M.C-T.).

**Gongylidiellum latebricolum* (Cambr.). A male in Parkhurst Forest (*Isle of Wight*) June 1946. Both sexes in moss, Abinger Common (*Surrey*) in Spring and Autumn. A rare species.

G. murcidum Sim. Still common in Wicken Fen, June 1946 and 1947.

**G. vivum* (Cambr.). A male, near Lincoln (*Lincs.*) (G.W.W.).

**Rhaebothorax faustus* (Cambr.). A pair of this northern species at Lake Vrynwy (*Montgom.*), April 1950.

**Gongylidium rufipes* (Linn.). A male, Fletwick (*Beds.*) (J.M.C-T.).

**Tmeticus affinis* (Bl.). In wet moss near Friday Street (Surrey); two females, Lake Vyrnwy (*Montgom.*), April 1950.

Donacochara speciosa (Thor.). Found abundantly in the clinker of a sewage-farm filter bed, Tonbridge (Kent) (A.D.B.).

**Oedothorax fuscus* (Bl.). Both sexes, Lake Vyrnwy (*Montgom.*), April 1950.

**Lophomma punctata* (Bl.). A female in a marsh at Ruislip (*Middlesex*), April 1948.

Lessertia dentichelis (Sim.). Females from Seven Sisters Coal Mine, South Wales (M.H.).

**Halorates reprobus* (Cambr.). A pair amongst seaweed, Clifden (*Co. Galway*), Sept. 1946.

**Ostearius melanopygius* (Cambr.). Both sexes from Seven Sisters Coal Mine, South Wales (M.H.); not previously recorded from Wales. A male in a garden at Coulsdon (*Surrey*), June 1950, and numerous of both sexes in early August.

**Peponocranium ludicrum* (Cambr.). A male, Lake Vyrnwy (*Montgom.*).

Maso gallica Sim. Still fairly common in Wicken Fen, June 1946 and 1947.

**Hilaira excisa* (Cambr.). A female, Lake Vyrnwy (*Montgom.*), April 1950.

**Maro minutus* Cambr. This little species seems to be fairly common amongst moss and pine-needles on Leith Hill (*Surrey*).

**Porrhomma pygmaeum* (Bl.). A male from South Wales (M.H.); not previously recorded from Wales; also from Lake Vyrnwy (*Montgom.*).

**P. convexum* (Westring). This is now the correct name for *P. prosperpina* Sim. (Holm, 1944, p. 130). Both sexes from Tonbridge (*Kent*) (A.D.B.).

P. microphthalmum (Cambr.). Males and a female from Shipbourne (Kent) (A.D.B.). A male on a tree trunk, Leith Hill (Surrey), May 1950.

P. egeria Sim. Found in a number of caves (M.H.).

**P. montanum* Jacks. A female, Lochnagar (*Aberdeenshire*), Aug. 1948.

**P. pallidum* Jacks. A female, Conach Craig (*Aberdeenshire*), Aug. 1948.

**Bathyphantes approximatus* (Cambr.). *Aberdeenshire* (B.F.).

**B. pullatus* (Cambr.). Two females, Fletwick (*Beds.*) (J.M.C-T.).

**B. nigrinus* (Westr.). Both sexes, Lake Vyrnwy (*Montgom.*), April 1950.
**Poeciloneta globosa* (Wid.). Females from Lake Vyrnwy (*Montgom.*).
**Floronia bucculenta* (Clk.). A female, Wootton-under-Edge (*Glos.*), Aug. 1944.
**Lepthyphantes expunctus* (Cambr.). Fairly abundant on pine trees, Crathie (*Aberdeenshire*), Aug. 1948.
**L. cristatus* (Menge). A pair, Lake Vyrnwy (*Montgom.*), April 1950.
**L. mengei* Kulcz. Females, Lake Vyrnwy (*Montgom.*), April 1950.
**L. minutus* (Bl.). *Aberdeenshire* (B.F.).
**L. obscurus* (Bl.). A female, Lake Vyrnwy (*Montgom.*), April 1950.
**L. tenebricola* (Wid.). A female, Peaslake (*Surrey*) (A.M.W.).
**L. alacris* (Bl.). A male, Lake Vyrnwy (*Montgom.*), April 1950.
**L. angulatus* (Cambr.). A male, Lochnagar (*Aberdeenshire*), Aug. 1948.
**Rhabdoria diluta* (Cambr). A female, Lake Vyrnwy (*Montgom.*), April 1950.
**Centromerus expertus* (Cambr.). A pair from Shipbourne (*Kent*) (A.D.B.).
**C. arcanus* (Cambr.). Abundant on and near Leith Hill (*Surrey*), in pine needles and moss, at all seasons. Lake Vyrnwy (*Montgom.*), April 1950.
**C. silvaticus* (Bl.). Leith Hill and Ranmore Common (*Surrey*), in moss.
**C. prudens* (Cambr.). A female, Cruach Craig (*Aberdeenshire*), Aug. 1948. A female, in pine needles, Leith Hill (*Surrey*), Dec. 1949. A female, Goatchurch Cavern (*Somerset*) (M.H.).
**Oreonetides abnormis* (Bl.). A female, Parkhurst Forest (*Isle of Wight*), June 1946. A female near Baginton (*Warw.*).
**O. firmus* (Cambr.). A female in heather, Hindhead (*Surrey*), July 1948. Also near Friday Street and on Leith Hill (both Surrey), April 1949 and Feb. 1950.
**Sintula cornigera* (Bl.). Both sexes in wet moss, near Friday Street (*Surrey*), and in moss on Leith Hill (Surrey), April and Dec. 1949.

Our thanks are due especially to Mr. E. Browning and the authorities of the British Museum (Natural History), to Professor G. C. Varley and his assistants at the Hope Department of the University Museum, Oxford, to M. M. André, of the Muséum d'Histoire Naturelle, Paris, and to Mr. A. A. D. La Touche, each of whom has provided us with facilities for examining specimens. We are also grateful to those gentlemen who have sent us interesting specimens of their own collecting and whose names appear in the above list.

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OBITUARY NOTICES

Merritt Lyndon Fernald, Foreign Member of the Linnean Society from 7 May 1936, died on 22 September 1950. He was born in Orono, Maine, on 5 October 1873, the son of Merritt Caldwell and Mary Lovejoy Heywood Fernald. Orono, a New England college town, is the home of the present University of Maine of which the elder Fernald, an outstanding educator of his period, served as first President. Of the family of five children two became well known scientists, one a chemist, and Merritt Lyndon Fernald, systematic botanist and phytogeographer.

Fernald's early years were spent at Orono where he attended the public schools of the town and then its college for a year. He was from the first interested in the natural surroundings of his home-region, particularly the native plants which he collected and studied intensively. In 1891, at the age of eighteen*, as the result of correspondence, concerning some of his collections, with Sereno Watson, then Curator of the Gray Herbarium, he went to Cambridge, Massachusetts, to carry on undergraduate studies at Harvard College and to serve as Watson's assistant in the herbarium. This was the beginning of his association with the Gray Herbarium which continued unbroken from his student days until his death.

Although his earliest duties in the herbarium resulted in many published studies on plants of the western United States and of Mexico, from 1902, when he was appointed instructor in the University, his botanical interests were focused chiefly on the flora of eastern North America, which in time he came to know more intimately than any other botanist.

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* When young Fernald's appointment to Harvard was made known in the small town of Orono the local newspapers enlarging the facts ridiculously said he was to be, at eighteen, Professor in the University ! In the archives of the Gray Herbarium is a charming letter from Mrs. Fernald to Dr. Watson expressing the family's embarrassment over the unfortunate publicity and indicating what she and her husband hoped the experience at a large University would mean to their young son.

He was a young man when he collaborated, as junior author, with Professor Benjamin L. Robinson, on the revision of the 7th edition of Gray's Manual of Botany*, the work which served as a standard text for students of botany in the eastern United States for the next forty years; and which formed the basis for perhaps his greatest contribution, the largely rewritten and much expanded eighth edition, published less than three months before his death †. The years between these two major achievements were very full ones in which his great activities in teaching and research soon made his influence felt throughout the botanical world.

In 1899 Fernald became one of the Associate Editors of *Rhodora*, the newly formed journal of the New England Botanical Club, and continued in that capacity until 1929. In that year he took over from Dr. Robinson the duties of Editor-in-Chief, which he performed with distinction until his death. From the time of its founding the standards of *Rhodora* had been unusually high and its editorial policy liberal. Neither factor was diminished under Fernald, with the result that both sides of innumerable botanical questions and many more detailed and critical monographs have appeared on its pages under his stewardship than is usual in a monthly botanical journal. He had a thorough appreciation of typographical intricacies and a sound understanding of problems involved in putting together a journal, so that he carried the technical aspects of his editorial duties with ease and facility, although he happily acknowledged the aid of his Associate Editor, the late Charles Alfred Weatherby, on whose linguistic ability, keen intellect and general good taste he greatly depended. He enjoyed the opportunity for contact with local amateur botanists which was possible through *Rhodora* and encouraged publication of their new records for the 'Manual-range'; often he converted their letters into brief notes of suitable form under their authorship.

As an account of his own botanical achievement the volumes of *Rhodora* from I to LII offer an almost complete story. His explorations are there meticulously recorded and the journal-portions, delightfully written chronicles of the trips covering both the personal and botanical high-lights, have long been read with great joy by taxonomists and non-taxonomists alike. These papers, prepared with skill and utmost care, are invaluable contributions to the areas to which they pertain. He enjoyed writing, wrote easily and well, and was particularly pleased to insert entertaining anecdotes either in the text or footnotes of his papers. These humorous bits show a delightfully puckish side of his character and often, as well, the peculiar fascination which the pun‡ had for him and some of his friends, notably Professor A. S. Pease of Harvard University and Mr. Bayard Long of the Academy of Natural Sciences in Philadelphia. That he revised and polished his own papers again and again before publication is obvious from their smooth style and well turned phrases. His own great care both as to the form and content of his work made him particularly impatient with colleagues less meticulous, a fact emphasized in many of his longer reviews and critiques which were written in righteous indignation over careless research and presentation.

From his early youth until only a very few years before his death Fernald spent a considerable portion of every year in the field. The first years were spent largely in the surroundings of Orono, but in the summer of 1892 he did his first botanizing with J. Franklin Collins in northern Maine; this trip being the forerunner of a long series of expeditions to northern New England and the Gaspé Peninsula which formed the basis of so much of his outstanding phytogeographical and floristic work. Since a detailed summary of the expeditions and a bibliography are given by Fernald himself in a graceful tribute to his friend Collins[*] I shall not cite any of the particulars here. I would simply note that the Gaspé discoveries and studies resulting from them, in addition to the Newfoundland and Nova Scotia explorations and researches, were such significant contributions to the knowledge of the flora of eastern Canada that, in recognition, Acadia University awarded him an honorary D.C.L. in 1932. Also the University of Montreal inivted him to give a series of lectures and receive an honorary D.Sc. in 1938; while in June of 1950 his Canadian work was further honoured by the award of the first Marie-Victorin Medal.

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* Robinson, B. L. and Fernald, M. L., Gray's New Manual of Botany, 7th ed. 1908.

† Fernald, M. L., Gray's Manual of Botany, 8th ed. June 29, 1950.

‡ Not many years ago Professor Fernald felt particularly deprived of this pleasure for a period because he had, at my suggestion, refrained from punning as a Lenten sacrifice!

The Canadian explorations are so ably documented by Fernald that there is little need to consider them in detail here, except to indicate that they resulted not only in making known scores of plants new to science and many others new to Canada, but, vastly more important, provided material for significant studies in phytogeography which have had a profound influence on botanical thought in the last four decades.

The first of these detailed studies was on *The Geographical Origin of the Flora of Newfoundland*[†]. The most detailed and important is the study on the *Persistence of Plants in Unglaciated Areas of Boreal America*[‡] which was based on an interpretation of the geological as well as botanical evidence gathered over a long period. Another important phytogeographical paper was that on *Specific Segregations and Identities in Some Floras of eastern North America and the Old World*[§].

During these years of exploration and research Fernald was pursuing many additional botanical interests as well. The New England flora was being investigated, with many of the companions of the more northern expeditions and others; and closely studied with the intention of preparing a Manual of the Flora of New England. Toward this end he had prepared keys and diagnoses for many groups, and had had many illustrations drawn, but the project was later abandoned and the work incorporated into the more inclusive Gray's Manual (8th ed.). He was active also in the affairs of the New England Botanical Club (turning over to it his large collection, 20,000 Maine plants in 1913), serving for a time as Curator of its herbarium; from 1911–1914 as its President; and for many years up to his death as a member of its Council. From the Newfoundland work he had hoped also to produce a flora, and only when time made its completion unlikely did he reject the plan and turn his accumulation of notes over to a younger man nearer the site. During his long career also he produced many monographic treatments of great significance. One of the most important aspects of Fernald's work through the years however, was his teaching, and its influence will continue through the many students who worked under him.

In 1905 he became Assistant Professor in the University and in 1915 was appointed Fisher Professor of Natural History, a distinction which particularly pleased him, since his predecessor in the chair had been Asa Gray[||]. He was a stimulating and enthusiastic lecturer, who had such thorough knowledge of his subject and took such delight in sharing it that his lectures seemed completely effortless despite their impressively good form. His course devoted to the flora of eastern North America was the most intensive and best known *, and its week-end field-trips, in the autumn to Cape Cod and in spring to northern New England were very enjoyable features. These were often the students introduction to field-work (and in the autumn to their professor as well) and there could be no pleasanter start. Professor Fernald not only had his favourite spots for special plants, but favourite native plants which must be tried for food and the experiment produced varying reactions in each new group. Another intensely interesting course concerned the History and Techniques of Systematic Botany. The historical portion of the course was particularly rewarding, for then Fernald would talk informally about botanists from the herbalists to the generation immediately preceding him, using as the basis of his accounts the great volumes, gathered and prepared by Mrs. Gray, of photographs and letters of botanists throughout the world. The accounts of his contemporaries, given with varying degrees of emotion, increased the unique character of the course.

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[*] Incidents of field-work with J. Franklin Collins in *Rhodora*, **44**, 98–147, pls. 696–707 (1942), and reprinted in Contributions from the Gray Herbarium of Harvard University—no. CXL (with same paging).

[†] Cf. *A Botanical Expedition to Newfoundland and southern Labrador*, in Rhodora, **13**, 109–162, pls. 86–91 (1911), and reprinted as Contributions from the Gray Herbarium of Harvard University, N.S. no. XL (with same paging).

[‡] (Mem. Gray Herb. 2), Mem. Am. Acad. **15**, no. iii (1925).

[§] In *Rhodora* **33**, 25–63, pl. 204 (1931). The questions involved in this study were still interesting Professor Fernald during his last summer, when he wrote, 'I received a Scandinavian volume with illustrations in detail of the groups covered in their first volume, which makes one gasp, for study of the plants so far as I have gone is showing that our American plant is specifically or varietally different from the Old World one with which it has been confused.'

[||] Foreign Member of the Linnean Society from 7 May 1850.

In 1930 he was a delegate to the International Botanical Congress at Cambridge; and devoted considerable time and energy, in preparation for and also after the Congress to matters concerning botanical nomenclature. An interesting sidelight to this visit to Britain occurred during a short holiday in Scotland which Fernald made with his friends Mr. Long and Professor Pease. There, in the region about Kinlochewe at the southeastern end of Loch Maree he discovered the plants reported in the paper *Some Rare Plants of Scotland* †. These records served to make him better known to British field-botanists (who have tried unsuccessfully to duplicate the records for the past twenty years) than much of his other work.

In 1935 Dr. Robinson, then head of the Gray Herbarium, died, and Professor Fernald was appointed to succeed him, as Curator until 1937, and from then until his retirement in 1947, as Director.

My own acquaintance with Professor Fernald began in 1935, at the beginning of the last full period of his career. He had just taken over his new administrative duties; the decision to prepare the eighth edition of Gray's Manual had recently been made; and the Virginian field-work, initiated by a brief excursion with Mr. Ludlow Griscom in 1933 was well under way. I had no idea when I asked permission to attend his lectures that autumn that I should stay at the Gray Herbarium for fifteen years as his assistant. There could hardly have been a more thorough or interesting experience for a young botanist.

During the whole period from 1935 to his illness of May 1950, the work on the revision of the Manual formed the background for most of Fernald's activity. The Virginian work ‡ was an especially important factor in filling in the floristic picture and the problems arising from each season's collecting more or less determined the order in which genera were revised for the Manual. Another factor in the order of revision was Professor Fernald's health, and when weakness from heart-attacks prevented him from climbing stairs he devoted himself to the Families on the ground-floor, just as later when he discovered that his eyesight was slowly failing he made a particular effort to finish those groups needing close microscopic examination. In his recovery from two heart-attacks and two operations for the removal of cataracts from his eyes Fernald's fundamentally good health and iron determination were apparent. His recovery from these four unpleasant experiences was unusually rapid and essentially complete, diminishing neither his enthusiasm and capacity for work nor his accomplishments.

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* This course had been well-attended for so long that in my day students whose mothers or fathers had taken it were numerous.

† Journ. of Bot. (Brit. & Foreign) **69**, 8 (1931). Included among the plants were *Eriophorum opacum* (Björnstr.) Fernald, *Scirpus hudsonianus* (Michx.) Fernald and *Antennaria hyperborea* D. Don.

‡ The expeditions were almost all made in company with Mr. Bayard Long whose keenness in the field was an especial joy to Professor Fernald. Various students and some colleagues from other institutions also took part in some of the trips, all of which are recorded in *Rhodora* and reprinted in the *Contributions from the Gray Herbarium of Harvard University*. The first in vol. **37** (1935) and the last in vol. **49** (1947).

At the time of his retirement as Fisher Professor of Natural History and Director of the Gray Herbarium in 1947 (well beyond the normal age for retirement) he had received recognition for his outstanding work from many organizations and learned societies. In addition to honorary foreign membership in several European societies he had served, in 1938, as President of the American Society of Plant Taxonomists; in 1941 as Vice-President of the American Association for the Advancement of Science; and in 1942, as President of the Botanical Society of America. He was awarded the Leidy Medal of the Academy of Natural Sciences in Philadelphia in 1940 'For many reasons, . . but especially because of his breadth of vision, building on a geologic foundation but with all due insistence upon taxonomic accuracy'*; and in 1944 the Gold Medal of the Massachusetts Horticultural Society for the book, *Edible Wild Plants of Eastern North America,* which he wrote with a former student, A. C. Kinsey.

His retirement also marked the beginning of the last phases of the Manual-work. In June of 1948 with the flora essentially complete, a preliminary conference with the publishers was held at the Herbarium. The following January, the enormous manuscript with the exception of two genera was sent to New York and another conference was held; but it was June of 1949 before the first proof-sheets arrived. From then on, for almost a full year, no day went by without proof to read. His long editorial experience stood Professor Fernald in good stead and his basic good humour enabled him to cope with the seemingly deliberate difficulties created by the printer. In May of 1950 with only a small number of revised pages left to check, his heart again was weakened and his general health much enfeebled. He recovered sufficiently however, to return to his work for a portion of each day, and was at the Herbarium when the first consignment of Manuals arrived from the Press in July. This was a month earlier than he had expected them and soon enough for him to receive, from his colleagues throughout the country, enthusiastic gratitude for a task superbly done.†

In his simplicity of manner, forthrightness, intellectual honesty, and scholarly insight he was surpassed by few. None exceeded his contribution to the area on which he specialized. Botanists in general, and American taxonomists in particular, have lost an outstanding leader and a most distinguished colleague. For the small share I had in his work I am deeply proud and grateful. BERNICE G. SCHUBERT.

Professor **William Thomas Gordon** died in London on 12 December 1950 after an operation for appendicitis. Though of Edinburgh descent, Gordon was born in Glasgow, on 27 January 1884, where his father was an engineer. He was, however, educated in Edinburgh at George Heriot's School and at the University. At the latter he studied under James Geikie and graduated B.Sc., with geology as his principal subject, in 1906. He worked on in Edinburgh for some time with a research fellowship and then went to Emmanuel College, Cambridge.

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* Proc. Acad. Nat. Sci. Philadelphia, **92,** 366 (1940).

† As this goes to press a detailed account of Fernald's life and work is about to appear in ***Rhodora*** **53,** for February 1951.

In 1910 he was appointed Lecturer in Palaeontology at Edinburgh and for the next few years was engaged in palaeobotanical work of great importance. He had found a series of finely preserved fossil plants in Lower Carboniferous beds near North Berwick and on these he did excellent work and published several papers. This was, though he did not know it then, the heyday of his research. As a result of this work he obtained the D.Sc. of Edinburgh and other distinctions came to him.

None the less, the call of an academic career soon removed him from the interests and charm of his fossiliferous district. He came to London in 1914 as head of the Geology Department of King's College in the Strand. His rank was that of Lecturer but this was soon increased to Reader and, in 1921, to the full Professorship.

In London nearly the whole of his activity was canalized into his teaching, not only of his students but of any who cared to come to him for advice or practical help. Sometimes he worked late into the night explaining a point or demonstrating how to cut a section.

He had, inevitably, heavy commitments on committees and interests in the learned societies. He was elected a Fellow of the Geological Society in 1919 and was several times on its Council as well as serving a term as Secretary and one as Vice-President. The Lyell Fund of this Society had already been awarded him in 1913. He joined the Linnean Society in 1925 and was a member of Council from 1930–1931. He was early (1913) elected a Fellow of the Royal Society of Edinburgh and received the Makdougall-Brisbane Medal in 1922. He was a regular attender at the meetings of the British Association and was President of Section C (Geology) at the 1934 meeting in Aberdeen, where his address was entitled *Plant life and the philosophy of Geology*. He was for some years up to 1949 Secretary to the Conference of Delegates of Corresponding Societies of the Association.

He travelled considerably for geological reasons and for the pleasure of it. His greatest love was for gem-stones. He had a vast knowledge of them, their structure and their commercial uses, and he amassed a considerable and valuable collection. One of his waistcoat pockets always sheltered his latest finds and he delighted to produce these and explain them to his friends.

He was a man of great personal charm, quite unassuming, and ever friendly and helpful. He had a fund of interesting geological stories and was never happier than when in conversation with fellow scientists. Since his retirement in 1949, with the title of Emeritus Professor, he had slackened little in his activities, though his health was far from satisfactory and he had been advised to rest. At the time of his death he was busily engaged in organizing a scientific exhibition and a series of lectures in aid of Crosby Hall.

He never married but the warmth of his friendship and the memory of his ready smile will linger amongst all who knew him, especially those who had the good fortune to be his students. W. E. SWINTON.

Albert Harry Hamm, A.L.S. *honoris causa,* died at Oxford on 9 January 1951 in his ninetieth year. Being the eldest son of a large family he received no formal education after he was twelve, when he assisted his father in printing. Thus his great powers of observation have never found their expression in literature to the extent that they deserved and only his friends knew his real worth as a field-naturalist in the widest sense. His youthful days were spent at Reading where he made large collections and acquired a sound working knowledge of British birds and insects.

E. B. Poulton, the Hope Professor of Zoology at Oxford, who knew Hamm's worth as an amateur entomologist, engaged him in 1897 as printer to help with labelling the continual stream of accessions, and between them they evolved what is certainly the best system of labelling that the writer has seen in any museum.

Being fully employed in this way, Hamm had little spare time for field work except at week-ends, but during luncheon intervals he frequented the fields and river banks near the museum and in this way made the numerous observations of which far too few ever saw the light of publicity. He was an expert photographer, and being an ardent believer in natural selection took many photographs of butterflies and moths at rest in their natural surroundings: in 1905 he showed how the 'Small Cabbage White' chooses for prolonged rest a surface upon which it will be concealed. His photographs, some of which were published by the Entomological Society in 1907 emphasize the importance of attitude as well as of colour and pattern.

In 1908 the Entomologists' Monthly Magazine published the first of his series of observations on the mating habits of the small flies (Empididae) some of which are familiar sights in summer flying backwards and forwards in swarms low down over the surface of water. These observations were continued over many years and were summarized by Poulton in the same magazine in 1913 (vol. **49**) and Hamm himself in 1933 (vol. **69**). A complete evolutionary sequence in the courtship of these predaceous flies was thus established, and three stages defined. (1) The prey is devoured by both sexes independently of pairing. (2) The prey captured by the male is sucked by the female during copulation. (3) The male picks up objects from the surface of water, sometimes merely fragments of vegetable matter, which are used to stimulate the female to copulate. The object thus chosen is surrounded by a balloon of fine silk, spun (as H. Eltringham showed) by special glands in the fore feet, and presented to the female. Even an empty balloon, abandoned by another fly, may be picked up and used as a symbolic wedding present!

The Hymenoptera, especially those that store prey for their larvae in burrows, were especial favourites of Hamm's, and he co-operated with Dr. O. W. Richards in important publications in 1926 and 1931 on their biology, with especial reference to the prey selected by them. His field observations enabled him in 1914 to collaborate with the late Geoffrey Smith in an article on *Stylops*, those strange insects of which the female, entirely parasitic on the bee or wasp host, exercises a profound influence on the development of secondary sexual characters.

Hamm was particularly interested in the leaf-mining larvae of Agromyzid flies and bred many of them with their parasitic Hymenoptéra. A curiously interesting observation was that hawthorn seeds, from birds' droppings, still contain living pupae of Chalcid Hymenoptera, which he bred out. The varied insect fauna of birds' nests and moles' nests provided collections of great interest which he gave to Oxford University, together with his general collection of Diptera, of which many were rare or little known in this country, and many other insects. Later in life when physical disability prevented him from wandering afar, he made important contributions to knowledge of the large flies which lay their eggs on decaying animal substances: by keeping dead snails in his garden he bred many such flies and was able to assign the sexes to each other.

If Hamm had possessed greater facility in writing, the literature would have gained enormously from his wide knowledge: as it is much of what he knew has gone with him, but those who had the privilege of his friendship, and of going out with him, will never forget him. He was most generous and kind in helping others. Other interests in his life were philately and bowls. His wife predeceased him by a good many years: he leaves a son and three daughters.

He was elected to an Associateship of the Linnean Society *honoris causa*, in 1925, and the University conferred the distinction of Honorary M.A. upon him in 1942.

G. D. HALE CARPENTER.